IMPACT REVIEW OF THE

ONCHOCERCIASIS CONTROL PROGRAM

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FOREWORD

The Center for Development Information and Evaluation (CDIE), in the Agency for International Development's (AID) Bureau for Program and Policy Coordination, is responsible for AID's impact evaluation program. The goal of the evaluation program is to assist the Agency's policymaking process and to improve project design, implementation, and evaluation. CDIE's objective in conducting evaluations of health projects is to provide useful information to two specific groups: (1) policymakers and decisionmakers who need to know how well our activities are accomplishing their intended purposes and (2) project officers who want to improve health project design and delivery.

The Onchocerciasis Control Program (OCP) is a large, multidonor-supported project that involves regionwide disease control operations to reduce the incidence of river blindness in seven West African countries. It represents one basic type of health project through which AID cooperates with less developed countries to help bring about improvements in the lives of people.

This review of the OCP looks at the project in terms of

-- The impact on the health of the target population directly from the reduced incidence of onchocerciasis and indirectly from the incidence of other diseases, including effects on child survival

-- Socioeconomic and environmental consequences of the onchocerciasis program in the target area, and subsequent national development programs in the onchocerciasis-freed areas

-- Organizational and management characteristics of the program including cost-benefit estimates, project sustainability after assistance is terminated, international coordination and cooperation, and developing country participation

Center for Development Information
and Evaluation
Agency for International Development
May 1986

PREFACE

For more than a decade AID has played an active role in the multidonor onchocerciasis program aimed at controlling "river blindness" in West Africa. This review, which comes at mid-point in the 20-year program, is an attempt to portray the impact of the program to date in terms of both disease control and welfare benefits. It is hoped that the review will contribute to the understanding of vertical health interventions as well as the usefulness of multidonor approaches in combating disease.

The six-person review team drew on analytical skills in the areas of entomology, epidemiology, economics, anthropology, public administration, and multilateral operations. A 3-day workshop was held for the team members in Washington before they left for West Africa, to familiarize them with the larger program issues as well as with each other's background and approach. The team spent 3 weeks in the field in August 1985, based in Ouagadougou. Besides visiting Bobo Dioulasso and Banfora in Burkina Faso, individual team members made trips to Mali (Sikasso, Finkolo, Bamako, Bourgouni), Ivory Coast (Bouake, Korhogo, Abidjan), Ghana (Tamale, Bolgatanga, Accra), Niger (Niamey), Togo (Lome), and Benin (Cotonou). In addition to interviewing community-level individuals, experts at the Onchocerciasis Control Program, and officials of the seven participating governments, team members talked with officials of the World Bank, the Food and Agriculture Organization (FAO), the World Health Organization (WHO), and the U.N. Development Program (UNDP). The analysis and conclusions in the body of the report are those of the team as a whole; the appendixes are the work of individual team members.

The team wishes to thank the dynamic Director of the Onchocerciasis Control Program, Dr. Ebrahim M. Samba, and his staff for their unfailing courtesy, interest, and assistance during the review.

SUMMARY

In July 1968, 27 experts, representing a variety of disciplines, gathered in Tunis to map a strategy for the control of onchocerciasis, or "river blindness," in West Africa. The meeting, sponsored by the Agency for International Development, the Organization for Coordination and Cooperation in the Campaign Against Endemic Diseases (OCCGE), and the World Health Organization (WHO), has had far-reaching consequences for millions of people in the savanna region of West Africa. In an area larger than France, the transmission of river blindness, known locally as the "poor man's" disease, has been interrupted by the Onchocerciasis Control Program (OCP) at a cost of

approximately $1 per protected person per year.{1} Approximately three million children born since the beginning of the program are free from the effects of onchocerciasis. In addition, significant increases in agricultural productivity and overall economic improvements have been made possible.

Onchocerciasis is a parasitic disease caused by a filarial worm (Onchocerca volvulus) which is transmitted to humans by the bite of the female blackfly (Simulium damnosum). No suitable drug to treat onchocerciasis has yet been developed. However, extensive experimentation with control of the blackfly vector carried out in Africa in the 1950s and 1960s indicated that human infection served as the reservoir of the parasite. Thus, if the transmission cycle could be interrupted long enough to allow the reservoir to die out, the spread of the disease could be stopped. Destruction of the fly larvae was shown to be feasible. Disease experts concluded that onchocerciasis could be checked over vast tracts of West Africa through vector control.

In 1974, at the request of the governments in seven affected West African countries, a 20-year onchocerciasis control campaign was initiated. Its overriding objective was

> to reduce the impact of onchocerciasis to a sufficiently low level so that it no longer represents either a public health problem or an obstacle to socio-economic development and also to maintain and adjust control activities so as to stabilize the disease at a tolerable level.

The control program is sponsored by four multilateral agencies: WHO, the World Bank, FAO, and UNDP. It currently covers portions of seven West African states. During its Third Phase (1986-1991), it will be extended into four additional countries. There are now 22 donors providing financing. Contributions to Phases One (1974-1979) and Two (1980-1985) of the program totaled $167.58 million. The Third Phase is expected to cost $134 million. AID has been the largest single contributor to this fund, having contributed 13.7 percent of the total budget during the first two phases (1974-1985); the World Bank has been the second largest contributor (11 percent).

The AID impact review team visited the seven OCP countries in August 1985. The team's overall conclusion is that the Onchocerciasis Control Program appears to be one of the more successful multidonor programs in the short history of development assistance. If OCP can sustain its performance during the Third Phase as well as the devolution period, when responsibility for onchocerciasis surveillance and control is transferred to the participating countries, the program effort should yield solid and sustainable returns in terms of both reduced human misery and new development opportunities.

The program results have been impressive so far. In 90

percent of the program area the transmission of onchocerciasis has been interrupted. This has already had a measurable impact on human health by decreasing the incidence of blindness, disability, and debility. An estimated 27,000 cases of blindness have been prevented in Burkina Faso alone over the past decade. The economic consequences of effective control are potentially large and could extend for generations. It is estimated that the control program has helped open up some 15 million hectares of tillable land in the former onchocerciasis-endemic areas.

Unfortunately, the successes of the program to date will not automatically lead to enhanced incomes and economic growth. Additional development investment is required to exploit the liberated areas. Although some investment is occurring through formal public programs and, on a larger scale, through private spontaneous endeavors, only a fraction of the potential is being exploited. New investment activities should be encouraged.

During the second half of the onchocerciasis control campaign (1986-1996), OCP will face new challenges. These challenges will flow from the effort to provide participating countries with a low-cost technology that will enable them to maintain onchocerciasis control.

It must be fully understood that the OCP strategy is one of control, not eradication. Although the blackfly population has been reduced to an insignificant level, it could resurge. The parasite is dying out in the resident human population, but movement into the freed zone of people from uncontrolled areas could restart the transmission cycle. This means that indigenous, national- and community-level capacities must be developed to maintain disease control after program termination. The program should intensify its research into low-cost treatment and control methods to facilitate devolution of responsibilities to local institutions.

{1} This is a rough estimate based on an OCP cost of approximately $160 million over 10 years: $16 million per year divided by 16.5 million people in the OCP area (1985 estimate) equals approximately $1 per person per year.

PROJECT DATA SHEET

1. Country: Regional (Volta River Basin)

   Phases I and II: Benin, Burkina Faso, Ghana, Ivory Coast, Mali, Niger, and Togo

   During Phase III, four additional countries will be included: Guinea, Guinea Bissau, Senegal, and Sierra Leone

2. Project Title: Onchocerciasis Control Program in the Volta River Basin
3. AID Project Number: 698-0399

4. Mode of Implementation:

   a. Grantee: Onchocerciasis Trust Fund administered by the World Bank

   b. Executing Agency: World Health Organization

5. Project Funding: Onchocerciasis Fund Agreement

		Total Funding	AID Funding
Phase I	1974-1979	58.2M	7.7M
Phase II	1980-1985	109.3M.....	15.3M
Phase III	1986-1991	133.7M.(est)	
Phase IV	1992-1997	56.0M (est)	

6. Purpose:

   a. To interrupt the transmission of onchocerciasis for a sufficiently long period (20 years) to permit the disappearance of onchocerciasis from the human population in the program area and to allow for reoccupation of river valleys in the Volta Basin

   b. To advance the state of knowledge of onchocerciasis and to refine methodologies for controlling the disease

7. Accomplishments:

   The Onchocerciasis Control Program (OCP) has effectively controlled "river blindness" in the program area. Some 27,000 cases of blindness have been prevented in Burkina Faso alone, and some three million children born since the program began are free from the effects of the disease. An estimated 15 million hectares of tillable land have been liberated from the threat of the disease, which makes possible significant increases in agricultural productivity and overall economic improvements.

8. Evaluations:

   The Onchocerciasis Control Program (OCP) is evaluated annually by its technical advisory committee. Special evaluations and reviews include the following:

   WHO, "Onchocerciasis Control Programme in the Volta River Basin Area, Evaluation Report, 1974-1979," Part I and Part II, 1978 (OCP/78.2).

   WHO, "Independent Commission on the Long-Term Prospects of the Onchocerciasis Control Programme, Final Report,"

August 1981.

WHO, "Ten Years of Onchocerciasis Control in West Africa," June 1984, (OCP 84.3).

9. Responsible Officials:

AFR/RA Project Officer(s): Dennis Conroy
Brian Wickland
John Rose
Jerry Wood

AFR/TR/HN: Dr. Joe Stockard (1974 - cont.)

IBRD: Mr. Peter Wright (1973-1977)
Mr. Bilsel Alisbah (1977-present)

OCP Director: Mr. Athemas Bellerive, Director of Division of Coordination, WHO/Geneva, 1973 (preproject)
Dr. Pierre J. Ziegler (1974-1976)
Mr. Marc Bazin (1977-1980)
Dr. Ebrahim Samba (1981-present)

GLOSSARY OF ABBREVIATIONS

AID - U.S. Agency for International Development

ATP - Annual Transmission Potential

AVV - Volta Valleys Development Agency (Autorit, des Amenagements des Vall,es des Voltas)

CMFL - community microfilarial load

CSA - Committee of Sponsoring Agencies

EAC - Expert Advisory Committee

FAO - Food and Agriculture Organization

IBRD - International Bank for Reconstruction and Development

MFAC - microfilaria in the anterior chamber

NOC - National Onchocerciasis Committee

OCCGE - Organization for Coordination and Cooperation in the Campaign Against Endemic Diseases (Organisation de Coordination et de Cooperation pour la Lutte contre les Grandes Endemies)

OCP - Onchocerciasis Control Program

ORSTOM - Office for Scientific and Technical Research Overseas

(Office de la Recherche Scientifique et Technique Outre-Mer)

PAG - Preparatory Assistance to Governments mission

TDR - UNDP/World Bank/WHO Special Program for Research and Training in Tropical Diseases

UNDP - United Nations Development Program

WHO - World Health Organization

1. PROGRAM SETTING

Onchocerciasis, or "river blindness," is a major parasitic disease that affects millions of people in the world. The African endemic areas, which lie between the 15-degrees north and 17-degrees south parallels, account for the major part of the estimated 20 million onchocerciasis sufferers in the world. In West Africa alone there are between 2 and 2.5 million sufferers, including 1 million in the Onchocerciasis Control Program (OCP) area. Of these, at least 100,000 are blind or have seriously impaired vision (WHO, OCP 84.3, 1984; WHO 1966).

Between 1950 and 1965, extensive research conducted in West Africa demonstrated the importance and seriousness of onchocerciasis as a public health problem and an obstacle to social and economic development. The disease affects primarily small, isolated rural communities. It can disrupt the balance of those communities' subsistence economies by handicapping or disabling a productive element of the population.

The disease is far more serious in the savanna than in the forest areas. In villages close to watercourses, blindness may afflict 10 percent of the population. Thus some valleys have been deserted for several kilometers on both sides of major waterways. Although onchocerciasis is not the only cause for desertion of the valleys, it does constitute a severe obstacle to settlement and productivity. In the contemporary African demographic context, the conquest of these readily irrigable lands, whose area was estimated at 65,000 square kilometers (sq km) in the original program area, is an evident necessity.

2. PROGRAM ORGANIZATION AND ACTIVITIES

When the Agency for International Development (AID), the Organization for Coordination and Cooperation in the Battle Against Endemic Diseases (OCCGE), and the World Health Organization (WHO) convened a meeting of disease control experts

in Tunis in July 1968 there was sufficient scientific evidence to show that a large-scale onchocerciasis vector control campaign was feasible in the West African savanna. A Preparatory Assistance to Governments (PAG) mission, financed by the U.N. Development Program (UNDP), was dispatched to West Africa in 1970 to draft a regional work plan for the long-term disease control program.

The report was completed in 1973 and approved in January 1974.{1}

The OCP's overriding objective was

> to reduce the impact of onchocerciasis to a sufficiently low level so that it no longer represents either a public health problem or an obstacle to socio-economic development and also to maintain and adjust control activities so as to stabilize the disease at a tolerable level.

2.1 Organizational Structure of OCP

The main components and functions of the managerial stucture of OCP are the following:

-- The Joint Program Committee (originally called the Joint Coordinating Committee) is the policymaking organ of OCP. It has representatives from the participating countries,{2} donor agencies,{3} and the four sponsoring agencies (WHO, World Bank, UNDP, and FAO). The committee oversees the Executing Agency, WHO, and meets once a year.

-- The World Health Organization is the Executing Agency of the program. The Agency, in consultation with the Committee of Sponsoring Agencies and the participating countries, appoints the Program Director, who is the chief executive officer of OCP. WHO provides technical and administrative assistance to the program (e.g., in insecticide and chemotherapy drug screening, hiring, and procurement) and is responsible for implementing approved action plans and strategies.

-- The World Bank manages the Onchocerciasis Trust Fund. The Bank mobilizes financial resources from the donor community and contributes from its own account. Funds are disbursed quarterly through WHO.

-- The UNDP and FAO, the other two sponsoring agencies, have special advisory responsibility for the exploitation of lands freed of onchocerciasis.

-- The Committee of Sponsoring Agencies comprises representatives of WHO, UNDP, FAO, and the World Bank. The Committee coordinates the activities of the

agencies, reviews OCP plans and programs, and monitors overall implementation. The Committee also acts as the Secretariat for the Program.

-- The Expert Advisory Committee comprises 12 experts appointed by WHO for 2-year terms. The Committee reviews the scientific and technical operations of the program and reports its findings to WHO. It meets twice a year and makes regular site visits. The Ecological Group, although invested with independent status, is a subgroup of the Committee.

-- National Onchocerciasis Committees have been formed in each of the participating countries to ensure liaison with the program and to coordinate national onchocerciasis-related activities, particularly in the onchocerciasis-freed zones.

Ouagadougou, Burkina Faso, was selected as the headquarters site for field operations, which began in 1974. OCP has four technical units: vector control, epidemiological evaluation, socioeconomic development, and administration and support services. The 1985 budget provides for 62 professional staff and 763 general staff (See Appendix D, Table D-1). Geographically, OCP has 7 sectors and 22 subsectors which communicate with Ouagadougou and OCP aircraft by a radio-telephone network. This extremely responsive network and an efficient logistics system provide the necessary infrastructure for the demanding operational tasks. Although the program is quite centralized in structure and operations, the need for swift response for larvicide treatment has necessitated some delegation of responsibility to sector and subsector chiefs. Supervision of these delegated responsibilities is facilitated by precise norms for surveillance, evaluation, and treatment.

The OCP headquarters in Ouagadougou has had considerable autonomy, which has contributed significantly to the success of the program. Because of extra-budgetary funding status, OCP has been able to develop special structures for policy and cost control (Joint Program Committee) and quality control and evaluation (Expert Advisory Committee). It also enjoys the special attention and support of the WHO Director General.

In administrative matters, OCP follows formal WHO procedures. The internal management of the program (planning, programming, budgeting, and performance systems) was also installed with the assistance of WHO. These systems have been upgraded over the years through the use of improved analytical and management tools. A challenging scientific task, an efficient and effective operation, a carefully constructed career ladder, and an international salary scale have created a highly motivated staff.

{1} Undoubtedly the design phase of the program would have taken even longer were it not for the energetic intervention of the

then President of the World Bank, Robert MacNamara, who had become convinced of the need to capitalize on river-basin development during a trip to the drought-ravaged Sahel in 1973.

{2} Ghana, Mali, Burkina Faso, Niger, Togo, Benin, and Ivory Coast. During the upcoming western extension, Guinea Bissau, Guinea, Senegal, and Sierra Leone will be added to the program.

{3} Belgium, Canada, the Federal Republic of Germany, France, Japan, Kuwait, the Netherlands, the United Kingdom, and the United States. In addition to the original nine donor countries, Finland (Phase III), Italy, Iraq, Ivory Coast, Norway, Saudi Arabia, Switzerland, African Development Bank, OPEC fund, Sabah Al-Salem Foundation, and three of the sponsoring agencies (UNDP, WHO, World Bank) have contributed to and/or currently support the program -- a total of 22 donors. AID has been the largest contributor to this fund (13.7 percent of the total budget during the first two phases of the program, 1974-1985), followed by the World Bank (11 percent) and the Netherlands (10.6 percent). (See Appendix D, Table D-2.)

2.2 Program Activities

2.2.1 Control Strategy

The strategy selected by OCP to control onchocerciasis was to destroy the larvae of the blackfly vector (Simulium damnosum), which develop from eggs deposited in rapidly moving waters of rivers and streams. Using helicopters and fixed-wing aircraft, the program treats approximately 18,000 kilometers (km) of river reaches with larvicides.

The OCP control strategy is executed in five phases (see Table 1). An area remains in the final maintenance phase until epidemiological evaluation indicates that reinfestation by blackflies would not result in recrudescence of onchocerciasis and that there are sufficient safeguards against the risk of the disease being reintroduced from outside the area. Responsibility rests with OCP for the first four phases and the first 5 years of the maintenance phase -- following which responsibility will gradually devolve upon participating countries.

2.2.2 Other Activities

Running parallel to OCP's vector control effort is its evaluation of epidemiological results, an activity that has become increasingly important in guiding control operations (see Section 3.3).

Increased opportunities for production and improvement of incomes for inhabitants of the program area, as well as migrants, were foreseen as important benefits of successful blackfly and

disease control. The OCP maintains a small socioeconomic development unit which cooperates with "socioeconomic cells" organized in the participating countries for the purpose of development planning and the promotion of economic activities (see Section 3.6).

Table 1. Onchocerciasis Control Program Strategy

Phase	Activity	Agent
Exploratory	Feasibility studies	OCP
Preparatory	Baseline data established	OCP
Attack	Intense vector control operations (originally 3 years)	OCP
Consolidation	Vector control operations as needed (2-3 years)	OCP
Maintenance	Epidemiological surveillance (10 years)	OCP (years 1-5) Nat'l Gov'ts (years 6-10)

Research and training are essential to program success, and 22 percent of the 1986 budget is earmarked for these requirements. The following topics receive high priority in the research program, much of which is carried out on a contractual basis: larvicide development, drug development, development of a rapid immunodiagnostic test for detection of early infection, the significance of the forest blackfly species as disease vectors, resettlement patterns, socioeconomic effect of resettlement, and socioeconomic development in areas where onchocerciasis is under control.

The program intends to intensify its training program to meet the new demands that will accompany the devolution phase. Most future trainees will be middle- and lower-grade technicians ready to work in the field, although some supervisory and managerial personnel will also be trained. The majority of the trainees will be nationals. Special efforts will be made to promote collaboration between West African institutions and to strengthen local educational facilities.

2.2.3 Cost-Effectiveness of OCP Operations

The absence of an alternative to destruction of larvae as a disease control methodology makes it difficult to assess OCP's cost-effectiveness. Instead, OCP relies on a cost-minimization

approach its program implementation. Ongoing monitoring and evaluation are stressed for operational effectiveness. Different flight configurations (fixed-wing and helicopters), schedules of treatment, types and dosages of larvicide, surveillance and testing techniques, and types of equipment (gas or diesel vehicles) are tested for efficiency and comparative cost.

OCP cost-minimization has been facilitated by several factors:

-- Well-defined and universally supported goals, strategies, and operational plans

-- Rigorous and exacting oversight through multiple review committees

-- Use of open and competitive bidding, using WHO's procurement system, for major contracts (aerial operations) and for purchasing equipment and supplies

-- The quantity and quality of the data generated to assist in budget and financial plan reviews

-- The management of the Trust Fund by the World Bank

-- The internal and external auditing instruments

Abundant accounting and financial data provided in monthly returns, quarterly and annual statements, and frequent review reports make external monitoring and evaluation manageable.

3. FINDINGS AND ANALYSIS

3.1 Summary Findings

The conclusions presented in this section draw heavily from several evaluation documents. The Onchocerciasis Control Program is evaluated annually by its technical advisory committee. WHO undertook a special evaluation and prepared a report, "Onchocerciasis Control Programme in the Volta River Basin Area, Evaluation Report, 1974-1979" (OCP 78.2). An ad hoc Independent Commission on the Long-Term Prospects of the OCP released a final report of recommendations in August 1981. In June 1984, WHO published a special scientific review of OCP, "Ten Years of Onchocercaisis Control in West Africa" (OCP 84.3). Finally, a long-term strategy was presented and approved at the December 1984 Joint Program Committee meeting.

The principal objective of the OCP from the beginning has been to control onchocerciasis. The strategy has been to interrupt the onchocerciasis host-vector-parasite cycle by destroying the blackfly vector. On that basis, the OCP, to date, must be considered one of the more successful multidonor programs in the history of development assistance. If OCP can sustain its

impressive performance during the Third Phase (1986-1991) and the devolution period, the program effort will yield excellent returns -- in terms of both reduced human misery and new development opportunities.

3.2 Impact of OCP on the Blackfly Population

3.2.1 Vector Control Efforts

The basic strategy of the OCP is to control onchocerciasis by attacking the blackfly vector, Simulium damnosum. The vector is vulnerable to attack because it undergoes larval development in well-defined regions of highly oxygenated water in flowing rivers and streams. The routine application of insecticides to the larval breeding sites effectively controls the blackfly and interrupts transmission of onchocerciasis.

The OCP program was planned on a large scale to cover the worst areas of blinding onchocerciasis in West Africa. The OCP zone is divided into seven uniform entomological and epidemiological sectors. Surveillance teams monitor control efforts throughout the area and identify breeding sites for the application of insecticides.

The blackfly population in the sprayed area has been dramatically reduced. Before control began in 1974, 66 percent of capture points had an annual transmission potential (ATP){4} of 700 of more, and only 9 percent were below the epidemiologically significant level of ATP 100. The 1983-1984 data show 86 percent of evaluated sites with an ATP less than 100 (of these, 64 percent had an ATP of less than 10) and only 1 percent (two sites) had an ATP above 800. Field visits to controlled (e.g., Burkina Faso) and uncontrolled areas (e.g., Idifiou, Togo) by the impact review team confirmed the impressive effects of control effects. In the controlled areas, team members were unable to collect any blackflies. Interviews with local people indicated that they scarcely remembered the blackflies. At the uncontrolled site in Togo, on the other hand, 18 blackflies were collected in 20 minutes by the evaluation team entomologist. (See Figure 1 for annual biting rates before OCP operations began and Figure 2 for ATP levels for the OPC area for November 1983-October 1984.)

The control program has overcome several operational obstacles that had been reducing the effectiveness of its efforts.

1. Blackfly reinvasion. Blackfly reinvasion seriously jeopardized the OCP strategy early in the control campaign. Rein

vading flies were carried on weather fronts and dispersed over several hundred kilometers in some cases. Extension of the control area into the reinvasion foci resolved the problem.

After 10 years of operation, one operational zone, comprising

most of Burkina Faso, has entered the maintenance phase. This zone includes 31 percent of the area currently under control. It is estimated that 58 percent of the total area including the extension area will be in the maintenance phase by 1988. Preliminary spraying of some reinvasion foci indicates that reinvasions can be effectively curtailed, a major achievement of the program.

2. Resistance to insecticide. Resistance to the insecticide Abate developed in 1981. This problem was overcome by the use of alternative insecticides. Considerable support and cooperation have developed among insecticide-producing industries, WHO, and the OCP, which provides unique facilities for testing new formulations in an aquatic environment.

3. Distinguishing the various species of the Simulium damnosum complex. There are at least seven members of the Simulium

Figure 1. Annual Biting Rates in the Oncchocerciasis Control Program Area Before Operations Began

(Insert Map)

Figure 2. Annual Transmission Potential in the Onchocerciasis Control Program Area, November 1983-October 1984

(Insert Map)

damnosum complex, with considerable overlap in the geographic distribution of the forest and savanna species. Current methods of field identification cannot always distinguish between the forest and savanna species, which is significant for the eradication program for two reasons: (1) forest species can develop resistance to organophosphate insecticides and (2) forest species appear to be associated with the transmission of a type of onchocerciasis that does not cause blindness. OCP has decided to temporarily discontinue control efforts on the forest species. Although this decision appears sensible at this time, OCP must also accelerate its efforts to learn more about the onchocerciasis parasite and its pathology.

4. Recrudescence of blackfly populations. Control of savanna species of blackflies has been remarkably effective, but small residual foci exist. When surveillance operations are reduced, blackflies may become reestablished in fly-free zones. In addition, while the reservoir of parasites will decline in the human population, migratory patterns will reintroduce the infection. Only an effective transfer of surveillance techniques and responsibility from OCP to national health services and the

availability of rapidly deployable insecticide teams will forestall such a resurgence.

OCP has developed a strong field-research capability. Using its own staff and local and overseas consultant personnel, the program has confronted and resolved problems as they occurred. OCP has awarded contracts for investigating fundamental biological issues such as species identification and vectorial capacity.

Outstanding research concerns remain, however. Research on destruction of adult blackflies has been disappointing and control efforts unrewarding. Future research may uncover alternate strategies to the aerial application of larvicides, which is too expensive an approach for national agencies to use after devolution. Ongoing blackfly control may also have significant economic implications if cultivators avoid disease-controlled areas because of the severe aggravation of numerous (albeit noninfective) fly bites.

The repeated, long-term application of insecticides to watercourses was a major concern early in the program. However, routine monitoring under the guidance of an independent Ecology Group, of 37 field stations and the analysis of the results for short-term and mid-to-long-term effects show no cause for major concern. Nevertheless, the Ecology Group has rejected several candidate insecticides because of their undesirable effects on nontarget fauna. This monitoring approach, which uses national employees from participating governments to collect field data, which are then analyzed by OCP hydrologists, could be used as a model during the devolution stage of the program.

Training has been an integral part of the OCP. Seminars are provided regularly for field workers. Devolution of responsibility for maintenance and surveillance efforts will require a new series of priorities for the training program. The current system of surveillance and treatment is effective but too expensive for national governments. Research on alternative strategies should be carried out in specified areas, and the experience of the Bandiagara experiment in local, manual application of larvicide should be studied.{5}

{4} The ATP is a measure of the number of infective larvae that might have been transmitted to a person sitting at a capture site 11 hours a day for 365 days. The limit of tolerability is set at ATP = 100.

{5} A potentially low-cost methodology may be derived from the experience in the Dogon Plateau in Mali. Here the population, in excess of one-quarter million, is culturally homogeneous and traditionally independent and self-sufficient. The blackfly problem occurs over a 6-month period when streams are flowing. In 1984, OCP gave Dogon responsibility for some control operations, under the guidance of an OCP staff member -- himself a Dogon. The experiment turned out well. The people demonstrated

that, with some training, they can capably perform the tasks of larviciding. While there are skeptics, some experts believe that the experience in Bandiagara can be expanded and duplicated elsewhere and lead to a high degree of community self-reliance after the "high tech" control phase is concluded.

3.2.2 Conclusions

1. The OCP has demonstrated that over large tracts of West Africa a successful attack can be mounted against an endemic disease by attacking the vector that transmits it from person to person at a single point in its life cycle, thus interrupting transmission of the disease.

2. The problem of insecticide resistance has been successfully managed by close OCP collaboration with international pesticide industries and an aggressive research program.

3. Reinvasion patterns have been understood and the phenomenon dealt with by OCP extension of the control areas.

4. The attack on the forest species of blackfly will be curtailed because it is believed that they do not transmit blinding onchocerciasis. This conclusion remains to be validated.

5. OCP personnel represent a major asset in trained human resources. Their services should be retained after devolution of responsibility to national governments.

6. OCP benefits from its liaison with commercially oriented industry, international scientific bodies, and individual members of the scientific community marshalled by WHO. This mutualism should be encouraged.

7. OCP has perfected a "high tech" methodology for vector control. A lower cost, more suitable control methodology is not yet available that realistically can be handed over to the national governments. The biology of the vector species must also be studied for alternative ways of control more suitable for use by national governments.

3.3 Impact of OCP on Disease Control

3.3.1 Disease Control Efforts

The disease manifestations of onchocerciasis are caused by a reaction to microfilariae that develops in the skin and eyes. Microfilariae are microscopic larvae produced in large numbers by

adult female filarial worms. The worms, Onchocerca volvulus, reside in nodules in male and female pairs, and can be seen and felt under the skin. Skin inflammation is caused by the microfilariae and produces intense itching. Atrophy and ulceration of the skin occur as the elastic fibers of the skin are destroyed. The most devastating complication of microfilariae is eye damage which can lead to blindness. The risk of eye damage is related to the intensity of the infection and to some other as yet unknown factor associated with the savanna species of blackfly. The infection load is measured by the number of microfilariae found in a skin-snip examination.

The successful interruption of the onchocerciasis transmission cycle has already had a striking impact on human health. The population of the original OCP area was estimated at 10 million, with 1 million of these infected by onchocerciasis, of which at least 100,000 suffered from serious eye lesions or blindness. Recent data suggest that most of the 3 million children born since the program started have been protected from onchocerciasis infection. The World Bank estimates that 27,000 cases of blindness have been prevented over the past decade in Burkina Faso alone (World Bank 1984).

Unlike the vector control operations that are decentralized to zone and sector chiefs, OCP epidemiological evaluation efforts are conducted from OCP headquarters in Ouagadougou. The epidemiological evaluation unit currently consists of an ophthalmologist, four epidemiologists, and 35 supporting staff. Biostatistical analysis is handled by two statisticians in Ouagadougou, backed up by two programmers at WHO headquarters in Geneva.

For its evaluation analysis, the epidemiological evaluation unit selected 142 villages from the onchocerciasis-infected area. Simple evaluations involve two skin-snips and measurement of visual acuity. In-depth evaluations include medical examinations and full ophthalmological review as well as the skin-snips. All findings related to onchocerciasis, or other eye diseases such as trachoma, are recorded on data forms and then entered in the computerized data banks.{6}

To measure the status of infection in a given village the epidemiological evaluation unit establishes the mean number of microfilariae per skin-snip for the population, referred to as the community microfilarial load (CMFL). The CMFL is a more sensitive index of intensity of infection than the onchocerciasis prevalence factor (the percentage of infected individuals in the village). After 8 years of vector control in the OCP central area, the CMFL has decreased more than 70 percent due to the drop in the number of adult worms as the older worms die.

The rate of decrease in the CMFL is encouraging since it suggests that the average life span of the adult female worm is 11.2 years rather than the 18 years estimated at the outset of the program. As a result, prevalence should drop sharply over the next 2-3 years as worms that developed from fly bites just

before OCP operations commenced reach their terminal stages. Recent data from a few villages confirm this OCP prediction: prevalence has dropped from 90 percent to 50 percent in the last 2 years after falling very slowly in the previous several years.

Ophthalmological survey data show that the load of microfilariae in the anterior chamber of the eye (MFAC) has decreased by over 80 percent in the central area. The significance of the lowered MFAC load has been confirmed: of 913 individuals studied in the central area, 70 percent who had previously manifested a heavy MFAC load no longer showed evidence of eye damage. Of those with severe eye damage in the beginning, one-third had recovered completely and one-third had no further damage. Blindness was found to occur only in those with recorded eye damage at the start of the vector control program. Thus the danger of becoming blind or developing eye damage is reduced, and damage is even reversed, once the rate of reinfection has been reduced.

Epidemiological research has been a major preoccupation of OCP. The epidemiological evaluation unit planned to convene a workshop in early 1986 to permit an international group of epidemiologists to confirm OCP's internal validation of the epidemiologic methodology employed to date, and to assess epidemiologic plans and research proposals for the future. These discussions should include consideration of whether present methods of skin-snip counts of microfilariae will serve satisfactorily for the final surveillance phase during and after devolution of control responsibility when only very low intensities of infection are expected.

In the quest for alternative, lower cost onchocerciasis control methods, OCP is involved in chemotherapy research, which is coordinated and evaluated by a Joint Scientific Committee.

{6} Until July 1985, all data had to be forwarded to WHO in Geneva, but there are now adequate microcomputer facilities and trained personnel to carry out the data analysis in Ouagadougou.

Through collaboration with Merck, Sharp, and Dohme, a promising single-dose drug (Ivermectin) designed to kill microfilariae has been developed and is in advanced stages of trial in over 300 individuals. Initial results are very encouraging. In collaboration with Ciba-Geigy, another new drug (CG 6140) has successfully passed animal screening tests and is in the first stage of clinical testing in the OCP testing center in Tamale, Ghana. This drug has potential for killing the adult worms.

On the assumption that Ivermectin or some other drug becomes available for widespread use soon, OCP's scientific working group should devise a strategy for deploying this new control method. The following issues should be examined: how will the drug be delivered to the affected population; should all those at risk be treated or should a diagnosis of onchocerciasis be required before treatment; and what will be the costs for delivery of the drug to the villages?

With excellent progress being made in the field of chemo-therapy, more attention can be devoted to the development of a simple, sensitive, and specific immunodiagnostic test for early onchocerciasis detection. Given the success of the Joint Scientific Committee in chemotherapy research, and the filariasis research work that has already been done by other agencies, OCP should consider forming another special scientific working group -- in collaboration with the UNDP/World Bank/WHO Special Program for Research and Training in Tropical Diseases -- to guide this research. This group could also help to manage research in three other important areas: detection of onchocercal larvae in the blackfly, the immunopathogenesis of the eye lesions, and the development of a vaccine to protect against onchocerciasis.

In accord with OCP's restricted mandate, little formal effort was made during OCP surveys to collect epidemiological data on diseases other than onchocerciasis. In recent years, however, it has been acknowledged that opportunities exist -- and should be taken advantage of -- for OCP to help upgrade national epidemiological evaluation systems without becoming distracted from its primary task. The 1985 Expert Advisory Committee recommended in its long-term strategy report that WHO "work with OCP ... to ... identify feasible, clear-cut goals with Primary Health Care and that specific research and development should be carried out in cooperation with the local health authorities in evaluating epidemiological techniques, field use of immunological tests, different delivery systems for drugs ..." (OCP/EAC 6.1). In conformity with this guidance, during the upcoming western extension of the control program, OCP will train national primary health teams in multidisease surveillance.

3.3.2 Conclusions

1. OCP has had a striking impact on human health in West Africa by decreasing the incidence of blindness, disability, and debility.

2. Disease prevalence should continue to drop sharply over the next 2-3 years as worms that developed from fly bites just before OCP operations commenced reach their terminal stages.

3. OCP collaboration with private pharmaceutical companies in the quest for alternative and lower cost onchocerciasis control methods should continue.

4. More attention should be given by OCP to the development of a simple, sensitive, and specific immunological test for onchocerciasis detection.

5. OCP has demonstrated that an endemic disease can be controlled through effective management of the combined resources of donors and participating countries. The challenge ahead is to achieve full integration of this

vertically organized disease control program within the national health delivery systems of each country -- at the national, regional, and community levels -- on a multidisease control basis.

3.4 Impact of OCP on Human Welfare

3.4.1 Impact on Well-Being

The OCP has transformed the lives and opportunities of many people -- even entire communities. It has worked "miracles" in cases where loss of vision was reversed by diminishing the rate of infection. In the freed zone, the young have been spared infection and have never known the nuisance effect of the fly. Some of the older people are less fortunate -- such as the Chief of the Madina-Diassa in Mali. He watched in the 1960s as his people became ill and gradually deserted the village. Finally only he remained to defend their claim to the land. Then as the control program eliminated the disease threat, the people returned. They now prosper in a showcase agricultural community. The onchocerciasis-blinded chief cannot see the results, but he fully grasps the transformation wrought by the program. The villagers' success vindicates his tenacity and provides him with security and contentment in his old age.

Descriptions of deserted river valleys and villages of the blind are accurate, but the picture is not uniform throughout the onchocerciasis zone. The incidence of onchocerciasis is proportional to the proximity of human hosts to white-water breeding sites and to exposure to the blackfly vector. The nuisance effects of the blackfly and the incidence of the disease are also inversely related to the density of the population. As human population density increases, the relative frequency of the disease diminishes. It has been observed that in high-density blackfly areas, as the human population density increases beyond 50 persons per square kilometer, the incidence of onchocerciasis declines to less than 5 percent and continues to diminish as the human population density increases. That is, there are limits to the quantity of blackflies that can afflict an area, and the need for blood meals is correspondingly finite and limited. Bamako, Mali, and other large towns and cities are located in the blackfly savanna but have little or no indigenous onchocerciasis or nuisance problems due to the blackfly. Although the control program spans a huge area, inhabited by some 17 million people in 1984, the majority of the inhabitants have not been at risk and much of the land remains onchocerciasis-free and exploitable. However, in less densely populated rural areas close to white water, the team estimates that without onchocerciasis control, one-tenth of the residents would contract the disease and one-tenth of these victims would become blind.

3.4.2 Impact on Production

Despite these serious concerns, the impression should not be given that little production takes place in the OCP zone. Indeed, some major investment programs were designed and executed in endemic areas even before it was clear that onchocerciasis would or could be controlled. Burkina Faso, most of whose productive area was blackfly-infested, was growing economically even before the control program began to reduce the onchocerciasis threat. Several ethnic groups (Birifor and Dagari) that practice intensive agriculture experience extremely low blindness rates in spite of living in onchocerciasis-endemic areas. By living in compact villages away from rivers and by clearing the ground cover closer to rivers, they have developed a social mechanism for resistance to onchocerciasis.

The detrimental effect on production of onchocerciasis and the blackfly is complex. The disease affects productivity by inducing various stages of physical debility, while the blackfly itself impedes production by the nuisance effect of its attacks. It has been estimated that the average loss of productive capacity as a result of the disease or the nuisance effect of blackfly attacks is about 5 percent of the capacity of the exposed work force (estimated at one million productive workers). This is equivalent to a production loss of about 10,000 tons of food grain.

OCP direct costs for the period l974-l985 were about $l67 million. The estimated gain in productivity resulting from disease control and reduction of blackfly incidence amounts to a maximum of only $4 million in aggregate production gains in l984. More important, however, is the removal of onchocerciasis as a constraint on the potential production possible on currently unexploited land and from other activities such as mineral exploitation, forest products, construction, and services.

An order-of-magnitude estimate of the minimum potential grain production of unexploited tillable land in the original OCP area (as much as l5 million hectares) is 2 million tons. Roughly, it could support some 10 million people, using indigenous technology and cultural practices. Although failure to exploit this potential production (two million tons annually) cannot be attributed solely to the blackfly and onchocerciasis, the control of the disease certainly advances production potential. This is the significant economic impact of the program: the production potential which is liberated.

Obviously, many factors other than disease -- cultural, legal, technological, and natural -- affect successful exploitation of the land. And many other costs (and benefits) are involved. Bringing new lands into production requires additional public and private investment and entails costs of relocation, lost production in the area of origin of the migrants, and social adjustments. There are detrimental as well as beneficial effects -- increases in other diseases, land tenure difficulties, and political and administrative problems. Nevertheless, a significant economic impact of the Onchocerciasis Control Program

is that it removes a major obstacle to exploitation and helps to create production opportunities which, in some countries, are the most important untapped resources.

The onchocerciasis-freed lands have attracted new immigrants in the thousands and new investments in the hundreds of millions of dollars. Documented successful investments undertaken in the area (e.g., the large cotton and maize production efforts in Southern Mali, the sugar refineries in the Ivory Coast and Burkina Faso, and the officially sponsored settlements of 25,000 people in the Volta River valleys) provide a means for estimating the level of economic activity. However, the development of some of these projects cannot be attributed solely to onchocerciasis control. Many decisions and actions that are independent of the program bear on the investment process. Similarly, it is not possible to estimate the effects of OCP on numerous other production initiatives, public and private, that have been undertaken. Even the role played by OCP in the decisions of thousands of people to immigrate into the zone is difficult to assess.

Development of the economies in the OCP area is, of course, the primary reserve of the individual member countries. OCP's role is limited to providing participating governments with support in collecting data on development projects under preparation or underway in the participating countries, and to facilitating intercountry exchange of experience on important socioeconomic matters. Individual countries have approached the development opportunities provided by the success of the OCP disease control in varying ways, resulting in varying degrees of economic progress within the protected areas. Although the economic benefits are difficult to quantify at this time, they are potentially immense and will most likely be felt for several generations. However, most of the potential economic benefits of the OCP remain just that: potential economic benefits. They will flow from the many public and private undertakings in agriculture or other productive areas and from the investment of labor as well as other required resources. In several of the participating countries the OCP land area is relatively well watered, fertile, and better than average in productive potential. Such conditions tend to ensure that these lands will grow in productive importance and will be attractive to more and more people. On the other hand, some onchocerciasis-controlled areas have lost population in recent years (e.g., provinces in northern Ghana and Togo) because of drought and the attraction of opportunities in the south. In addition, there is some evidence that inappropriate utilization of land by spontaneous migrants has had negative effects on the environment. The consequences of land use by migrants have not been adequately monitored or evaluated.

3.4.3 Impact on New-Lands Development

The development of new lands has taken place within the framework of planned government projects as well as spontaneously

through the repopulation of abandoned villages, intensified exploitation by pastoralists, and settlement of new farming communities. Planned settlement schemes represent an important part of new-lands development primarily in Burkina Faso, which in 1974 created the Volta Valleys Development Agency (AVV) to coordinate the settlement of the onchocerciasis-freed zones. Since 1976, the AVV has settled about 3,370 families (26,659 people) in 67 villages cultivating about 12,000 hectares of land. Proving too costly for widespread replication, this experience has led other governments to concentrate on improving and maintaining existing infrastructure rather than venturing into more ambitious undertakings. The AVV has reformulated its policy to ensure greater settler participation in infrastructure development and in covering the costs of relocation.

Settlement opportunities frequently mask severe problems. The first of these is obtaining legal access to land. The freed lands are often not "free," nearly always having prior claimants with traditional user rights. "Stranger" farmers are generally granted permission to use land for cultivation as long as space is available and the requests are not considered excessive. These user rights can amount to permanent tenure in some cases, but the arrangement has many variations, tends to be arbitrarily applied, and does not lend itself to large-scale population movements. Some government agencies have attempted to assert allocation rights to large tracts (e.g., the AVV in Burkina Faso), and others have attempted to apply a standard legal process throughout the territory. Neither approach has been free of problems. There have been confrontations between new settlers and traditional claimants, between the latter and absentee investors, and between central governments and traditional authorities. These problems have not been insurmountable, but strained relations have persisted in some areas. Participating countries must resolve the tenure issues early in the settlement process so that secure title is ensured, farmers are motivated to use sound agricultural/environmental practices, and the use rights of native farmers are protected from invading claimants.

The new lands present opportunities for enhancing the natural environment. By reducing the population load outside the zone, the fallow period can be extended and erosion can be controlled. Introduction of intensive agriculture, based on crop rotation and fertilizer, can avoid the soil degradation problems found in the overpopulated areas. Unfortunately, these environmental opportunities are not being taken advantage of throughout the program area. A survey of spontaneous settlers conducted by the AVV in 1984 claimed that among the negative effects of spontaneous settlement are deforestation, uncontrolled bush fires, killing of wild animals, overgrazing, extensive cultivation, and inefficient technology and cultivation of marginal lands. Such "mining of the land" takes place particularly when settlers cannot get clear title to the land and when spontaneous migrants violate the use rights of host populations. The claims of existing claimants should be supported when this presents the best use of the resources.

Although effective settlement of the new lands is a priority, global data indicate that the populations in the program area have not grown more rapidly than those outside the area. This is consistent with migration trends in recent years toward urban areas and toward the rapidly developing coastal countries. Furthermore, development of new agricultural land is complicated and frequently costly in comparison with other income opportunities. Hence, if settlement and land exploitation have important economic promise, participating countries will have to give more consideration to incentives. These incentives need not place an undue burden on fiscally pressed governments because the required measures relate less to monetary subsidies and more to policy issues such as agricultural pricing policy, trade regulation, and laws governing land acquisition and tenure. Efforts must also be made to protect existing resources from degradation through monitoring, and, where necessary, by intervention.

3.4.4 Impact on Infrastructure Development and Social Services

The control program itself has tangentially contributed to considerable infrastructure development. OCP has installed means of access along some of the rivers, provided health services in conjunction with its surveillance, and provided information on the physical characteristics of resources. Increased access to water has contributed to hundreds of water supply schemes for drinking, irrigation, and pastoral activities. However, the difficulties that accompany water development in the tropics and the degree of resolution of these issues are not, on the whole, much different from those outside the zone. A recent survey in part of the OCP zone revealed that only 22 percent of the families in villages had access to the simplest latrine, most drinking water is obtained from open streams and, of the wells in use, only one was covered. In addition, malaria and schistosomaisis are widespread and few control schemes have been undertaken.

Social services and the quality of life in the onchocerciasis-controlled zone do not differ much from similar areas outside the zone. Enrollment in primary schools within the zone varies from about 20 percent of those eligible in Burkina Faso, Niger, and Mali to 76 percent in the Ivory Coast, and the proportion of females is only 20 to 30 percent of that total. In the organized settlement of the Volta Valleys Development Agency (AVV) in Burkina Faso (see Section 3.4.3), however, school attendance is 174 percent of the national average.

Women in the zone are no better off and, in some respects, may be more disadvantaged than women outside the zone. In some cases women have not been provided with land for their own gardens, as had traditionally been their right. Even in planned settlements, women farmers receive less training and have less access to credit and technology than men. Children continue to be, on average, as undernourished in the zone as they are elsewhere in the Sub-Sahara.

3.4.5 Impact on National Health Systems

OCP operates in countries where health services have low priority in national budgets. As a result, health systems tend to be fragile and require external support. OCP, on the other hand, is a well-endowed, effective organization that has created a "can do" spirit, particularly among the disadvantaged rural populace. During its Third Phase, OCP will attempt to infuse some of this "can do" spirit into the national health services. OCP will work with national health services to find ways to sustain and expand the health benefits brought about through the program. OCP will organize joint epidemiological evaluation exercises as OCP agents broaden their one-disease approach into a multidisease detection effort while sharing their insights and techniques with national counterparts. As more experience is gained with improved fly traps and manual larvicide application, OCP agents will extend their efforts in the control area so that local capability will be in place for the disease-control maintenance phase.

OCP's formal training program should have a tangible impact on indigenous health care systems. Initially established as a program for OCP staff development, the training program was expanded in response to the concern expressed in 1981 by the WHO Independent Commission about the lack of OCP trained personnel on national health staffs. The Commission recommended that training types, levels, subject areas, and locations be defined more clearly and that a special unit be established to implement a more comprehensive OCP training strategy. Since the Commission's report, an improved training strategy has been pursued, even though the special training unit was never established.

The strategy envisages three levels of training:

1. Level 1, for university graduates seeking a specialization (1-3 years)

2. Level 2, for specialists seeking additional specialized training to meet OCP requirements (3-12 months)

3. Level 3, for medical officers and technicians interested in learning about the program methodology (4-6 months)

In addition to this conventional training, the program includes shorter term refresher, orientation, and on-the-job training. By mid-1984, OCP had trained or retrained 169 employees: 64 for itself, 66 for the participating countries, 24 for the OCP extension areas, and 15 for other African countries (see Appendix D, Table D-3).

OCP training opportunities have not been extended to women in the past and no women are employed by OCP except as clerks. These shortcomings should be addressed in the future at all levels.

3.4.6 Conclusions

1. The OCP has improved the well-being of millions of people in the neglected regions of West Africa by reducing the misery caused by onchocerciasis.

2. The OCP has given major impetus to new settlement by removing the threat of onchocerciasis as a barrier and thereby creating opportunities for increased production.

3. The OCP will have a positive effect on economic development by increasing the quantity and quality of the area's productive factors -- labor and land.

4. The success of OCP will not automatically lead to enhanced incomes and economic growth. Although the onchocerciasis-freed zone increases investment opportunities, socioeconomic initiatives must be taken outside of the OCP organization. Each development scheme must be evaluated in terms of its social and economic merits in the context of economic options in each country.

5. Efficient and secure means for controlling land acquisition and tenure and resolving conflict over land claims are crucial to successful exploitation of agricultural opportunities in the OCP zone.

6. Women do not fully benefit from the effects of the program and may be in some ways even less well off in the zone than elsewhere in the area. They have less access to land for their own garden plots in resettlement areas than previously, and they have less access than men to OCP and other training programs.

7. Although public health in the OCP zone has been enhanced by the program, significant additional improvements are required in other aspects of health and welfare within the zone and elsewhere in the participating countries.

3.5 OCP and Devolution

Since its inception in 1974, the OCP has envisioned that responsibility for onchocerciasis control operations within the context of national health administrations would gradually be assumed by participating countries. Yet by 1984 the devolution strategy was still incomplete. The donors, while eager to see more involvement -- particularly financial -- by the participating countries, were concerned about the transfer of complex OCP operations to fragile national health-delivery systems. The participating countries, while eager to incorporate OCP's efficient methodologies into their health systems, considered the

program costs beyond their means and, in some instances, accorded onchocerciasis control a low priority. In 1984 the Joint Program Committee reported, "the Programme and the participating countries have adopted a cautious, gradual approach, concerned above all with the technical, organizational and financial ability of the countries to take over tasks formerly carried out by OCP" (OCP/JPC 5.7, p. 17).

Implicit in OCP's cautious approach to devolution was the realization that a control strategy based on large-scale aerial activities would be difficult for national governments to sustain (WHO August 1981). Another factor contributing to the program's cautious approach was the lack of agreement on how much of OCP's activities would be assumed by national systems after the 20-year program period. Concerns were also expressed about the ability of national primary health care systems to afford a vertical disease control approach. Finally, confidence in the OCP's ability to devise an effective and low-cost maintenance program was at a low ebb because of problems with reinvasion and insecticide resistance.

Recently, planning for devolution has accelerated, and a smooth transition seems more likely. A consensus has emerged on the need for an intercountry facility after participating countries have inherited maintenance activities from OCP. This facility will be responsible for localized aerial larvicide applications to maintain control in reinvasion zones and will assume intercountry quality control and training functions as necessary. Devolution of hydrobiological monitoring is already in progress, and sharing of responsibility for epidemiological evaluation tasks will follow. Accordingly, during the western expansion of the program area, national primary health-care staff will assume OCP field epidemiological responsibilities within the context of a multidisease surveillance campaign. Health staff in parts of Burkina Faso already accompany epidemiologic evaluation teams in their visits to villages. OCP handles a portion of the training for these teams and will serve eventually as a source of highly trained nationals for the regional teams and medical centers. The Burkina Faso program should be monitored closely so that a detailed costing can be derived for use in designing other OCP-participating country transitions.

Undoubtedly, OCP's accomplishments over the past 2 years have helped to focus OCP's attention on the urgency of planning for devolution. Indications are that the OCP strategy will prove effective and that control will be achieved within the 20-year time frame. However, the program is one of control, not eradication. In the program area the blackfly population will be reduced to an insignificant level, but recrudescences can and will occur. The reservoir of parasites will die out in the human population, but migratory patterns will reintroduce the infection. This means that low-cost control methods manageable at the village level are needed to prevent the reintroduction of onchocerciasis. OCP research efforts must be intensified to learn more about the vulnerabilities of adult flies, to discover a simple diagnostic test to detect onchocerciasis in its early

stages, and to discover a suitable drug for mass treatment.

Thus the challenge of validating community control capability lies ahead. OCP is very much aware of the challenge. Working closely with national governments and research agencies, OCP will concentrate on creating local capability to control "the poor man's disease" in West Africa.

3.6 Afterword: Socioeconomic Development of Onchocerciasis-Freed Lands

As the OCP review task drew to a close, the AID team felt comfortable with its understanding of issues affecting OCP's current performance and future plans -- with one exception: what should be done to spur socioeconomic development in the onchocerciasis-freed zones?

The OCP role in promoting development activities has changed over the years. The 1974 preparatory mission indicated that the OCP socioeconomic development unit "would identify economic development projects within the programme area, and, at the request of participating Governments, assist in drawing up terms of reference for preinvestment studies and draft project documents for submission to bilateral and multilateral donor sources" (OCP 73.1).

OCP was never able to assume such an active role in the socioeconomic development process. In addition, the associated agencies, UNDP and FAO, have not played the vigorous advisory and support roles envisioned in early planning documents, nor have they actively promoted socioeconomic development in the freed zones. An early, short-lived attempt by OCP to draft area development plans -- including industrialization components -- was received poorly by the participating governments. The latter worried aloud about what they considered a disproportionate amount of development financing being tied up in onchocerciasis-control schemes even though onchocerciasis was only one of many diseases affecting their populations. Sponsoring agencies and donors questioned the advisability of diluting OCP's mandate by including responsibilities for the development of onchocerciasis-freed zones. During one of the annual Joint Program Committee sessions, the World Bank representative made clear his agency's desire that OCP not become involved in "rural development schemes which should be viewed as separate activities from the OCP and financed accordingly."

During the 1970s and early 1980s, the OCP socioeconomic development unit moved along in low gear largely because of recruiting problems -- it once took 2 years to recruit a unit chief -- and its search for a relevant role within the overall OCP configuration. During this quiescent time, however, the unit did manage to strengthen its links with the national "oncho cells" that had been established within the Ministries of Planning in the seven participating governments.

In 1984 at the urging of the Joint Program Committee, the OCP socioeconomic development unit was revitalized. In close collaboration with the participating governments, it undertook a global study of the impact of OCP activities on socioeconomic development, population movement, land occupation, productivity, and needs for technical and scientific assistance. The unit developed questionnaires for use at the district, village, and household levels to assist government efforts to collect comparable data. Several of the countries have forwarded drafts of their impact surveys to Ouagadougou where they are undergoing analysis -- eventually to be synthesized by OCP.

During the 1985 Expert Advisory Committee meeting, OCP experts noted the revitalization of the socioeconomic development unit and urged that the synthesis document be prepared immediately. The Committee unanimously approved the unit's new orientation and recommended that its name be changed to the "socioeconomic evaluation unit," to reflect its real function.

What seems to have evolved in the last 2 years, then, is a clearer understanding of the respective roles of the participating governments (primary responsibility) and the OCP (analytical support) in development of the onchocerciasis-freed areas. What remains unclear, however, is whether the development planning and implementation process in the onchocerciasis-freed areas is proceeding at a satisfactory rate. Given the amount of international and national resources being deployed to free these areas of onchocerciasis, it would be unfortunate if the lands remain unexploited or, more seriously, if resources are destroyed simply because of bureaucratic inattention. The results achieved by OCP should be used as a basis for mobilizing an international and national constituency to spur development in the freed zones. The question is, what development and conservation opportunities are being missed because of an uncoordinated effort among the participating governments, sponsoring agencies, and donors?

The impact review team concluded that the Committee of Sponsoring Agencies should convene a session soon, in collaboration with current and prospective donors, the participating governments, and OCP, to review the socioeconomic synthesis document now in preparation. During the review the following issues should be examined within each country context:

-- How complete is baseline data collection in the onchocerciasis-freed zone? What supplementary efforts are envisioned?

-- To what exent have development options been laid out and clear priorities established -- for private as well as public sector ventures?

-- Has a preinvestment study requirements list been prepared? How many of these studies have been commissioned? How many have been completed?

-- To what extent are participating governments willing to earmark their resources to help initiate activities in their onchocerciasis-freed zones?

-- Is existing information on human settlement and agricultural mechanisms to reduce the threat of onchocerciasis being incorporated into development planning?

-- How are activities being prioritized in terms of ensuring and enhancing child survival?

-- What efforts are identified in the national plan to enlist bilateral and multilateral support for priority activities in onchocerciasis-freed zone?

-- What additional steps should be taken, and by whom, to spur development and protect existing resources in the onchocerciasis-freed zones?

The intent behind the review session should not be to stimulate disproportionate interest in the onchocerciasis-freed zones, but to determine whether these exploitable zones are receiving due attention and resources. We cannot afford to leave this issue unexplored much longer.

4. LESSONS LEARNED

1. It is not likely that the Onchocerciasis Control Program would have achieved its current degree of success without the long-term financial commitment of donors at the outset. By signing the Onchocerciasis Fund Agreement on May 7, 1974, nine donor nations implicitly agreed to provide the bulk of financing required to implement a 20-year vector control program in West Africa. Without such a collective, long-term commitment, it seems unlikely that individual donor country support could have been sustained over the past decade. Serious doubts about OCP methodology and costs surfaced early in the program's implementation and were reinforced by difficulties stemming from blackfly reinvasion and larvicide resistance. These problems, combined with severe pressure on donor domestic budgets in the late 1970s, tended to dampen optimism in donor capitals about OCP prospects.

But donors had not entered into the 20-year commitment without setting up investment safeguards. Responsibility for management of program funds had been entrusted to the World Bank. Responsibility for project implementation had been vested in WHO, an organization capable of calling on the world's limited supply of qualified technicians to carry out the work. Expert monitoring panels had been established, and rigorous monitoring of work plans took place periodically. These quality control mechanisms ensured timely adjustments in program strategies that helped, in turn, to persuade reviewers in donor capitals that the

program was on a sensible path. The monitoring and ensuing adjustments, however, required time-consuming dialogue, negotiation, and experimentation. Without the security created by the long-term commitment, it is doubtful that this time-consuming approach to problem-solving would have been allowed to prevail by donor budget-cutters.

2. Complex disease-control programs like OCP may require some time for experimentation before they can become fully operational. The OCP experience reveals the need for patience and flexibility during the program's evolving phase. More than a decade of experimentation with various approaches was required before an appropriate intervention strategy could be designed. Several more years were needed to gain expert approval, to obtain governments' concurrence, and to line up donor financing. The basic strategy that ultimately emerged, however, has remained essentially unchanged throughout the program.

This is not to imply that the program designers strove in 1968 to come up with an all-encompassing vector-control strategy capable of dealing with all possible eventualities. On the contrary, it was recognized that even though the preferred, low-cost control technology was not yet available, an arbitrary starting point had to be chosen, using available technology, if the "poor man's disease" in West Africa was to be checked.

A deliberate attempt was made to focus onchocerciasis control on perfecting methods to destroy blackfly larvae. The program would proceed on a learning-by-doing basis, and adustments in program strategy would be made as necessary, as new scientific data were acquired. Early in the program OCP managers had to decide what priorities should be given to chemotherapy research and the economic development of the onchocerciasis-freed areas. OCP elected to play a central role in chemotherapy research, but used contractors for much of the work to avoid replicating existing research infrastructure and to conserve program energy for the principal task of vector control. On the issue of socioeconomic development, OCP staff argued that their program energies would be severely diluted were they to try to assume responsibilities that, in the final analysis, could only be carried out by the governments of the onchocerciasis-freed areas.

It was not until the early 1980s -- more than a decade after the initial 1968 design session in Tunis -- that the OCP program strategy began to jell operationally. Further evolution may be expected as the program strives to accommodate the mandate of devolution.

3. Vertical disease control projects may play a useful role in helping to reinvigorate primary health care delivery programs. Vertical approaches to disease control and prevention have been controversial. Some programs like the International Smallpox Eradication Campaign of the 1960s have been faulted for leaving behind little local capability to deal with alternative health problems after effective control had been achieved -- largely with expatriate staff and resources.

Few would suggest, however, that the current stages of onchocerciasis control in West Africa would have been reached had a horizontal program approach been used. Had the program been integrated fully from the outset into the national primary health care systems, OCP resources would have been diluted over a variety of disease fronts. In addition, staff experts would not have enjoyed the flexibility required to pursue their control and research objectives. Finally, the program thrust would have been slowed by overriding local political concerns.

The OCP has earned an impressive degree of credibility in West Africa. OCP staff are viewed as experts dedicated to relieving the misery of onchocerciasis. OCP planes and vehicles are allowed to cross national borders routinely in areas where such crossings can be fraught with red tape and petty harassments. It is common knowledge that OCP priorities are established on technical rather than political grounds and that fiscal resources are tightly controlled. The impressive statistics on OCP achievements to date can be recited by villagers as well as Presidents and Ministers of Health.

While it is too early to suggest that OCP's credibility will help reinvigorate national health care systems, that is the goal. The first stage in the devolution process was to involve local personnel in hydrobiological monitoring. The second step will be to include data on other diseases in OCP's epidemiological surveys and evaluations to enable development of a technically sound multidisease attack strategy that can be adapted by national ministries. The next step will be to accelerate research on least-cost onchocerciasis control methodology (e.g., fly trapping and manual spraying) so that governments in the 1990s will not have to use the cost-intensive approaches of the 1960s. The final step will come during the devolution period when OCP-trained personnel are integrated into the primary health care structure and used to direct multidisease control functions. If the process is successful, a vertical disease control program will have served as an entry point for more effective primary health care.

4. Undertaking development assistance programs within a multilateral framework and implementing them through established international structures can greatly facilitate success. Donors agreed in 1968 to undertake the OCP program on a multilateral basis principally because of cost considerations and the need to pool scientific data derived from bilateral disease control experimentation. In retrospect, it is clear that OCP's chances of success were enhanced by its multilateral framework and its reliance on recognized international structures for program implementation.

The World Bank and WHO, as respected institutions, were able to tap worldwide resources and to accommodate the fledgling OCP within an established framework. By locating itself within the WHO structure, OCP has been able to benefit from the support of established bodies and procedures. OCP had access to worldwide

talent in recruiting its personnel and to internationally respected experts to serve on its various monitoring bodies. By using the WHO career employment structure, OCP has been able to provide an excellent system of benefits and inducements for recruiting staff and keeping morale high. Indeed, because of the high quality of OCP staff and members of its monitoring bodies, donor agencies have tended to delegate their monitoring responsibilities and refrain from involvement in the month-to-month management of the program. This built-in restraint has served OCP well, especially during periods of fiscal stress and changeovers of political administration in donor countries. Respect for the multilateral configuration of OCP, and donor cohesiveness, has also tended to encourage participating government representatives to shield OCP activities within their borders from any adverse effects arising from national policy change or political pressures.

This insulation from many of the exogenous factors that normally impinge on bilateral development activities has accorded the program a degree of autonomy -- even within the WHO structure -- that enables it to direct its energies toward overcoming technical rather than administrative or political obstacles. In this atmosphere of relative calm, even severe problems like fly reinvasion and resistance to larvicides can be patiently analyzed, and appropriate strategy adjustments can be made.

Thus, a sturdy multilateral framework has enabled OCP to draw guidance from its sponsors without becoming weighed down by bureaucratic restrictions, short-sighted advice, or political considerations. It is doubtful that such conditions would have prevailed in a bilateral project working outside established international structures.

5. Vigorous, sustained research efforts are crucial for the ultimate success of the OCP in West Africa. Normally, any large-scale program such as OCP will be beset by a number of unpredictable problems both technical and biological. Fortunately, the importance of applied research was foreseen, and early OCP budgets included adequate financial allocations for research efforts in vector control. Technical problems such as the design of the spraying apparatus and routines for the application of insecticide from aircraft were handled well early in the program. More troublesome problems such as fly reinvasion and insecticide resistance required painstaking field research. That these problems are now understood and can be handled is a reflection of the capability of OCP's research arm. Continued research is still required to provide a less cumbersome means for identifying blackflies, more insight into the pathological process involved in onchocerciasis, identification of parasite larvae in the vector, and more rapid methods for diagnosing and treating the disease.

Socioeconomic research has not received the same sustained attention because of OCP concentration on the physical problem of vector control. The program designers should have arranged for

baseline data collection during the preparation phase. This is now being done for the western extension program by an independent agency. Similarly, during the early execution phase while OCP was concentrating on eradication, the participating countries might have been induced to compile socioeconomic data. Fortunately, this is now being done at the national level with the encouragement of the OCP socioeconomic development unit. Clearly this area has not received the attention required to permit meaningful analysis or to provide a basis for socioeconomic development activities.

6. The aggregate economic and social welfare benefits and costs of long-term disease control programs are difficult to calculate precisely. The rationale for this health initiative derived primarily from socioeconomic development motivations and objectives. Although epidemiological data permit a credible, order-of-magnitude estimate of the potential income benefits arising from the avoidance of blindness and clinical onchocerciasis, these benefits constitute only a fraction of the economic potential freed by OCP activities. Although the income effects of the program are likely to flow for an indefinite period after control of the vector has been achieved, it is possible only to speculate on the nature and magnitude of these benefits. It is clear, however, that without additional attention by participating governments, donors, and sponsoring agencies, very significant opportunities for social and economic welfare benefits and resource conservation will be jeopardized and perhaps ultimately lost.

7. International financing is particularly indicated at early stages of regional disease control efforts. Onchocerciasis is beyond the control of individuals, communities, or even entire nations. Given the present dimensions of onchocerciasis and the present technology for controlling it, reliance on local or national government financing would result in insufficient resource allocations and inefficient and ineffective control efforts.

A geographically broad assault employing technologically sophisticated methods may have been the only way to efficiently reverse and control onchocerciasis. In these circumstances, the individual rural West African could have helped little. A multinational effort and substantial external resources were required for the task.

8. The expensive, sweeping, high-technology control methodology adopted during the early stage of the OCP must be replaced in the maintenance phase by a low-cost, low-technology, focused-control methodology, accompanied by local capacity building. Experiments with manual application of larvicides and new surveillance techniques suggest that most aspects of the maintenance phase can be managed by local communities. Although some OCP professionals remain skeptical of lay capability for maintaining control, it was OCP that took the initiative in introducing locally applied control techniques to the Dogon people of Bandiagara.

New methods of control also may be developed. Adult flies may be vulnerable to olfactory traps. Social mechanisms, such as human spatial groupings based on disease control principles, may be adopted at low cost. Research is needed in these areas. Because people are only too aware of the effect of blackflies on their comfort, health, and incomes, it is not unreasonable to expect that they will be able to manage a system of local surveil-lance and control. Moreover, because the disease-causing microfiliarial parasite will no longer be an epidemiological threat, the existence of pockets of blackflies in uninhabited areas will be of little importance.

During the devolution phase of OCP and thereafter, it will become increasingly possible for individuals, communities, and nations to assume the financial and physical responsibilities for maintenance of control of the blackfly. The Ministries of Health can incorporate onchocerciasis diagnosis into their overall monitoring systems and coordinate control within their respective countries. A minimal international facility will be required to coordinate the efforts of participating countries and to provide contingency support when extraordinary effort is required. Conceivably, the entire maintenance phase could be sustained by the target countries.

9. Highly specialized project components should be contracted out. OCP has contracted out several aspects of its operations (aircraft operations, larvicide and therapeutic drug development, environmental monitoring), which has resulted in improved efficiency and considerable cost containment.

10. If the goal of socioeconomic development of the onchocerciasis-freed lands is to be achieved, initiatives must be taken outside the OCP organization. Tying these diverse functions and programs together administratively in the OCP would have jeopardized the achievement of principal project goals. The OCP was designed to interrupt transmission of onchocerciasis over a 20-year period to permit disappearance of the parasite from the human population in the program area and to allow for reoccupation of river valleys in the Volta Basin. While vector control seems assured, a directed and coordinated initiative must be taken outside the OCP organization if socioeconomic development goals are to be achieved.

At its inception, some donors envisioned a substantial role for OCP in promoting development activities -- from identifying economic development projects to assisting interested governments in planning preinvestment studies and drafting project documents for submission to donor agencies. The OCP socioeconomic development unit, however, was never a major part of the vector control operation. The modification of the oversight structure of the OCP, which subsumed the economic development functions under the Expert Advisory Committee, both reflected and anticipated the minimal role of the program in socioeconomic development activities. The associated agencies, UNDP and FAO, have not played the vigorous advisory and support roles envisioned in early planning documents. Participating

governments were expected to seek FAO, UNDP, and World Bank support to actualize some of the development potential of the freed zones. However, the structuring of such support has not been successful.

Mid-point in this 20-year effort the vector control results achieved by the OCP have not been used to mobilize a national or international constituency to spur development in the freed zone. The OCP has clearly stated that its role in the development of the onchocerciasis-freed area is to provide analytical support. The recently completed study by the OCP socioeconomic development unit of the impact of OCP activities on socioeconomic development, population movement, land occupation, productivity, and needs for technical and scientific importance should be used as a base to mobilize participating governments, sponsoring agencies, and donors. Unless a directed and coordinated initiative is undertaken in the near term it is unlikely that the goal of socioeconomic development will be realized in any way proportional to the successful accomplishment of vector control.

APPENDIX A

THE IMPACT OF VECTOR CONTROL

by Clive J. Shiff

1. INTRODUCTION

Onchocerciasis is a disease arising from the interrelationships of three agents: the host (man), the parasite (Onchocerca volvulus), and the vector, a blood-sucking insect, the blackfly (Simulium damnosum), with man the reservoir of the parasite due to his long-standing chronic infection. The cycle of the infection from man to fly to man is an obligatory one and, when broken in some manner, will cease and the disease will decline. There are as yet no satisfactory means of treating people so as to remove the reservoir of infection.

However, the vector does have an "Achilles heel", a stage in its life cycle when it is vulnerable to attack. Blackflies have an aquatic stage in their development during which their larvae require highly oxygenated water. The female adult fly, having had a blood meal, will seek a spot on a nearby river where white waters occur in the presence of vegetation or some other substrate. She dives into the water, clings to the substrate and quickly deposits 400-600 eggs in a sticky residue. The developmental stages, egg-larva-pupa, take about 2 weeks and occur throughout the year. The larval stage is active and lasts approximately 7 days. During this time the larvae feed passively by the filtration of nutrient particles carried in the current. It is at this time that they are vulnerable to attack with insecticides formulated against the larvae -- larvicides.

During the period 1950-1965, research into the problem of

onchocerciasis in both East and West Africa indicated that the fly populations could be controlled with larvicides (e.g., Barnley 1956, Roberts et al. 1967). Similar results were achieved by ORSTOM entomologists in pilot campaigns in the Volta and Bougouriba Rivers in West Africa (Philippon 1977). This research provides the background for the specifically targeted Onchocerciasis Control Program (OCP). The basic strategy is to control the vector, S. damnosum s.l., by applying larvicide to breeding sites along the rivers, covering a sufficiently large area to prevent significant repopulation by the fly. Because the life span of the adult parasite is approximately 11-12 years, the control should remain effective long enough for the parasites to die out in the infected population. The initial area of the program was some 654,000 square kilometers (sq km), encompassing Burkina Faso and large areas of Mali, Ivory Coast, Ghana, Togo, and Benin. The larvicide of choice for the program was a formulation of temephos (Abate); chlorphoxim was chosen as a backup. It was to be applied to breeding sites on all rivers in the program area by means of helicopters.

1.1 Organization of the Vector Control Component

The program has been organized as a massive, well-planned, concerted attack on the vector. In order to achieve this, it has been necessary to build a cohesive team with a number of branches operating in collaboration. To do this and to ensure the success of the operation, the OCP has had to be flexible in its response to changing circumstances and to maintain the research capability to cope with problems that arise. The effector arm of the program is a fleet of spray helicopters which operate in liaison with teams of entomological monitors who keep track weekly of the populations of blackflies in the treated area.

Originally, the program area was divided into 7 sectors with 22 subsectors. When the area was extended in 1977-1980 by some 110,000 sq km, the boundaries of these were altered so that there are still 7 sectors and 22 subsectors. However, where control has been effective some subsectors have been expanded to accommodate for the extra territory covered. In the initial phase of the program, there was 15,175 km of watercourse; the further extensions into Ivory Coast and Ghana increased this to 18,850 km.

Each sector is managed by an entomologist with support staff and vehicles, and is a part of a radio net that covers the whole program area. The subsectors each have an entomological technician in charge. The subsector headquarters is equipped with a number of survey teams and is also part of the radio net. There are currently 90 survey teams. These teams visit, on a routine basis, previously surveyed and identified breeding sites (gites). At these sites, blackflies alighting on the collector over a 10-hour period are collected and returned to the laboratory for identification and dissection. The data are incorporated in the calculation of annual transmission potential

and weekly biting rate and are used to determine whether the site will be sprayed during the next treatment cycle. Routinely, some sites are examined each week during the season; when the rains come, the number of survey sites is increased to compensate for increased habitat. Important sites are visited weekly, while other sites are visited every 2 weeks. In this case a 2 x 10-hour catch is made. Including sites in the preparatory attack phase, 329 localities are examined routinely. In addition, some site data are collected using a Bellec trap, a device which snares the female blackfly as she is laying her eggs.

The information collected by the survey teams each week is collated at the weekend and transmitted together with readings of the water levels in rivers to the zone headquarters. This information is used to determine treatment sites and insecticide dosages.

Aerial application of larvicide requires a formidable amount of organization. Seventy improvised heliports and some 155 fuel and insecticide storage depots have been established over the area. Ensuring that these are adequately stocked is a major logistical effort, particularly during the rains. Weekly treatment of breeding sites is the basis of the vector control program. The chemical is applied in a transverse swath upstream from the site. From its point of application, the insecticide forms an effective wave that carries over varying distances. During the dry season, breeding sites are often separated by stretches of stagnant water which a wave of insecticide cannot cross, so each site is treated individually. By measuring the discharge rate of the river, and by trial and error, the extent of effective "carry" is known. With Abate, this may extend up to 40 km. With Teknar this is much less, usually no more than 5 km. The normal treatment with Abate is calculated to be 0.05 parts per million (ppm) x 10 minutes (min) at high water and 0.1 ppm x 10 min at low water; the dose of Teknar is calculated to be 1.6 ppm x 10 min. Hand application of larvicide is done in certain areas, but this comprises only a small part of the program. It is most effective in the Bandiagara River, where only Abate is used.

1.2 Strategy for Vector Control

The OCP area is quite heterogeneous in terms of entomological data, epidemiological findings, and program operations. To establish a basis for rational planning, the area has been divided into 10 operational zones (00Zs) in which these conditions are more uniform. OCP planning and strategy for vector control operate in several phases. These constitute major facets of the operational program and are fundamental to the process of blackfly control.

1. Exploratory phase. Epidemiological and entomological baseline data are gathered. Other feasibility studies

are made, but without any commitment to continue further operations.

2. Preparatory phase. During this phase, which may last more than a year, exploration and survey of the area are performed to identify breeding sites, to work out the logistics of operation, to undertake trials to measure susceptibility of the blackflies to larvicides, and to identify the species that exist. Further epidemiological and socioeconomic baseline data are collected and the necessary staff are trained.

3. Attack phase. Vector control applications are initiated and are carried out regularly and without interruption. Treatment entails complete coverage of all breeding sites and will reduce the blackfly population considerably. This phase normally lasts 3 years but may be extended if epidemiologically significant numbers of blackflies are present. It may also be reduced if successful control is achieved, as is proposed in the current long-term strategy. During this phase intensive entomological surveillance is undertaken.

4. Consolidation phase. Vector control operations are no longer carried out regularly and without interruption but are determined by the findings of the entomological teams, which remain very active. This period may extend for 2-3 years or until the entomological teams determine that satisfactory annual transmission potential (ATP)1 levels have been achieved. Settlement of the area can be encouraged at this time.

5. Maintenance phase. Vector control is no longer a constant component of the OCP operation but is confined to foci of blackfly reinfestations. Entomological surveillance is reduced gradually and concentrated on identified potential reinvasion sites or local breeding areas. The maintenance phase is directed at preventing transmission of O. volvulus in the population and will continue until epidemiological data indicate that recrudescence of the parasite is unlikely in the event of blackfly reinfestation of the areas. Chemotherapy would be valuable at this time and would reduce the duration of the maintenance phase. Current epidemiological data indicate that the maintenance phase should extend for 10 years.

2. RESULTS OF CONTROL

The OCP has had a major impact on the blackfly population in the program area, and this impact has been expressed in many ways, both positive and negative. The initial success of the operation was blunted by massive waves of reinfestation from outside the controlled area. Evidence showed that infected

female flies could travel several hundred kilometers borne aloft on weather fronts, particularly the intertropical convergence zone which moves from the southwest during the rains. Another major result of control operations has been the elucidation of the S. damnosum species complex. It has been found that there are at least seven species of Simulium in the area. These species are difficult to tell apart. However, they are biologically very different, have different habitat requirements and, most important, have different vectorial capacity for the parasite. This is of extreme epidemiological concern. As would be expected, after several years of larviciding using one insecticide (Abate), organophosphate resistance developed and had to be counteracted. The fact that the OCP has developed and maintained a strong capacity for applied research operated by alert and dedicated individuals has enabled it to confront and solve such problems.

{1} ATP is a measure of the number of infected larvae that might have been transmitted to a person sitting at a site 11 hours a day for 365 days. The limit of tolerability is set at ATP = 100.

2.1 Impact on the Blackfly Population

The blackfly population throughout the present control area has been reduced to undetectable levels in many regions, and the numbers have been reduced in other areas to levels below the epidemiological threshold of ATP = 100. Table A-1 shows the percentage of capture points in the initial program area yielding infective bites classified according to ATP categories.

This spectacular reduction of the blackfly population in major regions of the control area has been noticed by the people, many of whom do not recall the existence of the pest. This is particularly noticeable in the resettlement areas. Zone 00Z 01 has been in the maintenance phase for nearly 2 years. In 1986, given a start in the control of areas that are major sources of reinvading blackflies (00Z 09, in the southern extension, and 00Z 10.1, the first part of the western extension), maintenance will be extended to 00Z 02 and 00Z 08, a total area of 420,000 sq km, or 64.2 percent of the original program area.

2.2 Reinvasion

The phenomenon of blackfly reinvasion was noted in certain of the program areas as early as 1975. It was well known and expected that adult Simulium flies could migrate considerable distances, so penetration was not unexpected. It was hoped that the large extent of the program area would minimize the effects of reinvasion. However, the problem became severe because reinvasion was so widespread. The investigation and identification of the sources of reinvading blackflies represent

a major accomplishment of the field entomologists. Many of the identified reinvasion zones were taken into account during the initial expansion of the program in 1977, and the remaining areas will be controlled during the planned extensions to the southeast and west. Preliminary data indicate that localized spraying in

Table A-1. Percentage of Capture Points in the Initial Program Area Yielding Infective Bites, Classified According to ATP Categories

ATP Category	Prior to 1974	1975-1976	1976-1977	1977-1978	1978-1979	1979-1980	1980-1981	1981-1982	1982-1983	1983-1984
100	9	58	65	61	75	75	73	71	85	86
100-199	5	18	21	10	8	5	8	11	7	7
200-399	20	15	6	9	9	10	7	9	4	2
400-799	10	6	6	8	6	4	9	5	3	4
800+	56	3	2	12	2	6	3	4	1	1
No. of Capture Points	105	98	109	210	216	207	220	159	131	184

Source: OCP 84.3; G. Zerbo (personal communication) 1985.

Guinea (Sassandra River and Sankarani basin) has limited reinvasion into the southwestern parts of the program area.

Table A-2 contains abbreviated data from a site subject to reinvasion by savanna and forest flies, the latter being resistant to Abate. Reinvasion occurs with the onset of the rains (weeks 23-24). The females are parous (contain fertile eggs) and therefore are not recently emerged. Application of larvicide between weeks 25-26 has reduced the reinvading savanna blackflies, but not the forest species. This example is given to show how data are collected and interpreted in assessing the effects of larviciding.

Table A-2. Results of Weekly Biting Catches From a Site (Gite 3) in the Bandama River Basin (Bouake sector) Showing Seasonal Increase Due to Reinvading Savanna Flies

	Season					
	Dry (1984)	Dry (1985)	Dry (1985)	Wet (1985)	Wet (1985)	Wet (1985)
Week No.{a}	48-52	1-4	20-22	20b-24	25	26
Bites in 10 hr per Person/Day						
Savanna Flies	0	0	0	2	12	3
Forest Flies	0	0	0	1	3	30

{a} Numbered consecutively from January 1.
b Week of rain onset.

2.3 The Species Complex

A biological species is a unit or group of organisms that is capable of interbreeding. They may have habits and characteristics different from closely related species, but it is not always possible for entomologists to recognize the differences between the species without resorting to complicated taxonomic techniques. In S. damnosum s.1. there are at least seven members of the species complex. Of those occurring in the OCP area, it is possible to differentiate the species crudely into forest forms (i.e., S. sobrense and S. sanctipauli) and savanna forms (S. sirbanum and S. damnosum s.s.). The characteristic used for this differentiation, wing tuft color, cannot be applied to the more ubiquitous S. squamosum or other members of the complex.

Differentiation of the complex is important because the vectorial capacity of the forest species is not well understood. For example, in infectivity experiments, S. sobrense and S. sanctipauli are highly efficient vectors, S. squamosum are intermediate, and S. sirbanum and S. damnosum are lowest on the scale by a factor of 1:10 (OCP 84.3). Yet the forest blackflies are not associated with severe blinding onchocerciasis, and a plurality of the parasite is suspected. This represents a major deficiency in our understanding of the problem and is a major concern of OCP. Forest species are difficult to control. Resistance to Abate has developed among them and must be managed. The habitat presents many logistical problems. OCP decided in 1985 to suspend treatment on those reaches of rivers where only S. sobrense and S. sanctipauli occur, because apparently they are not associated with severe blinding

onchocerciasis. No decision has yet been made with respect to S. squamosum, which is found in both forest and savanna areas.

2.4 Insecticide Research

In a program that is based fundamentally on the use of insecticides, one would expect to find a well-developed research branch. The OCP has excellent support in this area. The great dedication of field teams to their task is an example of the spirit of the organization as a whole. The long hours involved in field experiments (often more than 24 consecutive hours) and the collection of larvae by wading in raging streams are a testament to outstanding field research.

Candidate formulations of insecticides are tested in Lome, Togo, in a well laid out laboratory program using an established protocol. The larvae used in these trials are collected from the field because there is no successfully colonized S. damnosum s.1. The tests are carried out in troughs into which the field-collected larvae are introduced. By exposing them to various concentrations of trial insecticides, it is possible to work out the minimum dose required to kill all the insects. This is the LC100 and can be used to compare the relative efficacy of the trial compounds. Promising formulations are tested in the field at the measured LC100. Those that are recognized as effective and that have been demonstrated as acceptable to the teams concerned with toxicity to non-target fauna are given full-scale field trials. A new insecticide, permethrin (Talcord [R]) is completing operational trials.

Collaboration between the OCP vector control unit staff and the insecticide industry worldwide is well developed and mutually supportive. The availability of a dedicated and effective team of field entomologists represents a resource to the insecticide industry which should be exploited to the fullest. The association should be seen as mutually beneficial. Perhaps one of the major contributions of OCP to its donor nations is that it provides the facilities to test their products and the various formulating emulsions in such a comprehensive manner. In 1984-1985, 29 formulations were received in Lome. Of these, 27 have been lab-tested and 20 are in first-stage field trials. The results have been very encouraging, particularly in demonstrating that new classes of chemicals are good candidates for the program. Because cross-resistance usually occurs among the constituents of a particular class of chemicals, the more classes available, the more effective the control arsenal. OCP now has effective chemicals and formulations in four classes:

1. Organophosphates Temephos and Chlorphoxim

2. Biological agents BTI H-14 (new formulations may double or triple the efficiency of the present formulation)

3. Pyrethyroids Permethrin (Talcord [R])

4. Carbamates Carbosulfan (R)

Additional experiments are being carried out on insect growth regulators under contract by OCCGE Institut Pierre Richet in Bouake.

Insecticide teams have found a negative correlation between resistance to organophosphates and resistance to pyrethyroids. Flies resistant to Abate are 10 times more susceptible to permethrin than other blackflies. Thus, it is unlikely that resistance will be a major threat for the duration of the program. However, the problem of resistance is real, and monitoring of susceptibility is an on-going task of the insecticide evaluation team.

Research on insecticides that act on adult blackflies is also taking place. Some preliminary applications of adulticides have been made from helicopters, but with inconsequential results. Should this approach be attempted, considerable caution must be used. Successful adulticiding programs can be developed only after detailed knowledge of the behavior of the target species is available. This is an area where information about Simulium is particularly lacking. Thus, general application of insecticide to gallery forest to destroy an insect whose activity is unknown, whose specific distribution is unknown, and which constitutes only a minimal amount of the arthropod biomass is to be criticized.

Another area for active investigation should be the olfactory and color signals used by the blackflies in locating a host. If the various factors that attract Simulium to its source of blood meal can be identified, then it may be feasible to use this information on signals in designing an effective trap for the adult flies that could be used to reduce person-fly contact. Such a weapon would be particularly valuable for use during the devolution process. Concerted efforts should be made in this area, as has been done with considerable success in the study of tsetse fly behavior (Vale 1974, 1980, 1981).

2.5 Environmental Impact of Blackfly Control

The effects of regular use of insecticide in watercourses over a period of 20 years were of great concern to the participating countries. Serious disturbances of the freshwater ecosystems were likely to occur. The program was required to establish an independent advisory body, the Ecology Group, to ensure that vector control did not endanger the environment.

The Ecology Group established a strict protocol to be followed to detect changes in aquatic fauna. It is carried out by national teams who operate in their own countries, monitoring specific localities on a routine basis. Results are transmitted

to the hydrobiologist in Ouagadougou who correlates the information. Currently 37 stations exist: 12 in Ivory Coast, 10 in Ghana, 7 in Togo, 7 in Benin, and 1 in Burkina Faso. Of these, 26 stations are monitored for fish species and 19 for invertebrate fauna; some stations are used for both groups. Distribution and abundance data are examined for a wide variety of invertebrates. For fish, a coefficient of condition is measured. Standard hydrobiological procedures are used for sampling. Although the system works quite well, some of the national teams monitoring the work need to be admonished for tardiness or producing questionable data. The problems have usually been resolved in discussion or by personal contact between the Director of OCP and ministerial personnel in the participating country.

The results are analyzed for short-, medium-, and long-term effects. The short-term effects are measured by collecting organisms which detach and drift after the application of insecticide. Medium- and long-term effects are measured by observing changes in the proportions of various taxa or groups of organisms. So far in the program the environmental effects have been small, with the biota showing considerable resilience. However, the freshwater habitat is dynamic and is exposed to natural catastrophes such as flooding and drought. It is difficult to interpret the results of the monitoring, except to say that no major imbalance of concern has yet been noted and that, in spite of many years of insecticide application, the invertebrate and fish fauna appear to be relatively unaffected.

The hydrobiological unit of OCP serves another important function which is directly concerned with the testing of candidate insecticides: it monitors the effects on non-target organisms during laboratory and initial field trials. The unit has been responsible for the rejection of at least three new insecticides and has raised concern over the use of permethrin and carbosulfan. Tolerable limits for the use of these products are being established.

3. RESEARCH

The OCP has a competent applied research team as an integral part of its activity. Many of its achievements have already been discussed, but the program has generated many problems of a fundamental scientific nature that need to be resolved. The resources of various World Health Organization (WHO) programs have been used to identify appropriate research organizations, and OCP has established contracts with competent authorities to investigate these problems. In the field of entomology and parasitology, the topics under consideration for further research are the cytotaxonomy of the species complex, morphometric analysis of adult flies, and biochemical taxonomic methods. It is hoped that the research will clarify the relationships of the various members of the species complex and lead to the discovery of some method of identification applicable to field or field

laboratory conditions.

OCP has sponsored research activities with ORSTOM and OCCGE entomologists to investigate the ecology of larval, pupal, and adult stages of the various species of Simulium. In parasitology, the focus has been on the taxonomy of the parasite, its biology, and its detection in people. Apart from diagnosis, which is discussed in Appendix B, two fundamental problems require resolution. First, it is necessary to determine the biological status of the two forms of O. volvulus, the one associated with forest species of blackfly, which appears to cause benign disease, and the form transmitted by savanna flies, which produces the debilitating disease. Are they different species of parasite? What characteristics are associated with increased pathology in people? What physiological processes occur in the blackfly itself? The second thrust of this research is to try to distinguish the various species of infective larvae L3 which may be found in the head capsule of a blackfly. It is currently impossible to tell whether the parasite larva is one of the human forms or the bovine parasite O. ochengi, which is also common in the area. Obviously this is of vital importance in the interpretation of ATP data.

An area of research mentioned in the long-term strategy proposal (OCP/84.4) and vital to the devolution process is the development of simplified or alternative means of blackfly control. Most field entomologists agree that residual pockets of blackflies exist in the program area and that recrudescence will occur once the maintenance work is stopped. Although this would not result in an immediate resurgence of onchocerciasis, the disease will gradually reappear from introduced cases. Routine control of developed areas by local national teams or village health workers must be instituted, and OCP should be developing techniques that could be used effectively in the absence of the sophisticated control teams now available. Experiments with simplified techniques could be started in parts of Burkina Faso (00Z 01) under the umbrella of the current surveillance teams.

4. TRAINING AND DEVOLUTION

Training has been an integral part of the OCP, and the majority of the technical staff have benefited from the well-planned, highly relevant opportunities offered to new recruits and established professionals alike. From 1974 to July 1984, a total of 169 people received training or retraining in the following disciplines: entomology (89), parasitology and epidemiology (32), hydrobiology (22), ophthalmology (18), health economics (8), and other areas (10) (see Appendix D, Table D-4).

This training program will need to redirect its efforts toward training national staff in disciplines relevant to maintenance and surveillance activities, which will become national responsibilities after devolution. The long-term strategy proposal envisages employing nationals in the majority

of posts in the western extension area, and OCP will contribute to the education and training process for those people. Currently the OCP holds five bursaries at the Institute of Veterinary and Medical Entomology at Bouake.

The directorate and staff of OCP are fully aware of their responsibilities regarding devolution and have prepared logical plans for the process. The task of blackfly control will be integrated into appropriate health delivery systems considered by the national governments as having local priority. To this end, National Onchocerciasis Committees meet regularly under the auspices of the OCP Directorate to consider these matters. The actual techniques for blackfly control that will be feasible for use in the national program still need to be developed. Presently, it is agreed that the burden of larviciding will be an activity of an intercountry facility, unless research reveals another avenue of attack that would be more suitable for national-level control activities after devolution (e.g., adulticidal traps using odors or other attractants).

5. CONCLUSIONS AND LESSONS LEARNED

1. If carefully planned, a target-oriented vertical health program based on vector control over a large area can be effective and fiscally sound, despite the use of sophisticated and apparently expensive techniques. Furthermore, even with the availability of pilot studies, good rationale, and a feasible budget, no vector control operation should proceed without strong local potential for field research. OCP has been beset by a number of serious biological problems that could have jeopardized the whole effort had it not had an effective field research capability.

2. A well-organized health program that has high visibility and is perceived as achieving results may develop a high level of international credibility that can supersede local political instabilities and change and can act as a cohesive force for improvement of health in the region. Such a program can be exploited by WHO in the creation of intercountry facilities that may be of value in future health-oriented activities both local and regional.

3. The experience and professional expertise developed in such a program represent a major investment in knowledge and effective management. This expertise is valuable to the region and should not be allowed to dissipate at the end of the contractual period. Career opportunities should be made available among the regional and national authorities.

4. A considerable amount of the work undertaken by field research workers remains unpublished and thus unavailable to the scientific community. The OCP should hold regular biennial symposia to which field staff would contribute research papers, based on their normal work. Contributions from research workers

or authorities in other related areas could also be solicited, thus achieving some measure of international cohesion. The material presented at the symposia could be published by WHO in appropriate periodicals.

5. The program represents a resource to the world of science and industry and has demonstrated through contact and collaboration that it can serve those clients while solving its own immediate problems.

APPENDIX B

THE IMPACT OF DISEASE CONTROL

by Howard C. Goodman

1. EPIDEMIOLOGICAL EVALUATION AND BIOSTATISTICS

The Onchocerciasis Control Program (OCP) performs epidemiological evaluations and biostatistical analysis as part of its program activities. Four hundred ninety-three villages in the program area, including the western extension, were selected for study. After an initial evaluation, a representative sample of 142 villages was chosen for longitudinal studies; epidemiological surveillance teams conduct surveys in these villages every 3 years.

Unlike the vector control operations, which are decentralized to zone and sector chiefs, the epidemiological evaluation teams are based in OCP headquarters in Ouagadougou, Burkina Faso. The epidemiological evaluation unit consists of an ophthalmologist, four epidemiologists, and supporting staff. Biostatistics is handled by two statisticians in Ouagadougou, and two World Health Organization (WHO) programmers in Geneva.

Between October 1983 and August 1984, 11,529 people were examined in 59 villages in the seven participating OCP countries. Simple evaluations were carried out in 41 villages (two skin-snips plus measurement of visual acuity); a detailed evaluation, including a medical examination and full ophthalmological examination, as well as the two skin-snips, were carried out in the remaining 18 villages. The ophthalmologists not only describe any eye lesions (damage), but also count the number of microfilariae floating in the fluid of the anterior chamber of the eye (between the cornea and the iris/lens). All findings related to onchocerciasis, or other eye diseases such as trachoma, are recorded on data forms from which they are entered into the computerized data bank. Until July 1985, all data were sent to WHO, Geneva, and entered into the WHO computer. In response to recommendations by the Expert Advisory Committee and the Joint Program Committee, a biostatistics unit under the OCP Director now has sufficient trained personnel and microcomputer facilities to enter and analyze all data in OCP headquarters in

Ouagadougou (with the WHO computer used as a backup). Data from the vector control unit forms are now also entered by the staff, and staff of the epidemiological evaluation unit are being trained to enter the data from the epidemiological forms. Thus, the goal of performing statistical evaluation of data in close contact with those obtaining the data has been achieved.

The population of the original OCP area was estimated at 10 million, of whom 1 million were infected with onchocerciasis; of these, at least 100,000 had serious eye lesions or were blind. The present OCP area of operation includes an estimated 16.5 million people, which will increase with the western and southern extensions to about 22 million. The cost-effectiveness of preventing disability and of postponing death (the average length of life in West Africa after blindness is estimated to be 9 years) was calculated at $20.00 per year of healthy and productive life, and $150.00 per year after weighting for age and for time (i.e., benefit sooner rather than later) (Prost and Prescott 1984).

2. IMPACT ON DISEASE

2.1 Onchocerciasis

The disease manifestations in individuals infected with onchocerciasis are caused by the reaction produced in the skin and eyes by the presence of microfilariae. Microfilariae are the microscopic larvae produced in large numbers by the adult female roundworms, which reside in nodules (in male-female pairs) that can be seen and felt under the skin. The skin inflammation caused by the microfilariae produces intense itching, and atrophy and ulceration of the skin occur as the elastic fibers of the skin are destroyed. The most devastating complication produced by the microfilariae is eye damage which can lead to blindness. The risk of eye damage is related to the intensity of infection, which is measured by the number of microfilariae found in a skin-snip examination. A fragment of skin (obtained using a small standardized punch) is placed in a drop of saline, and the emerging microfilariae are counted. Severe eye damage can be seen after only a few years in individuals carrying large microfilarial loads. Progressive inflammation and scarring of the cornea leads to blindness, as can inflammation in the rest of the eye (the retina, iris structures, and the optic nerve).

The successful interruption of transmission in the central program area has already had a striking impact on human health. In June 1985, the Expert Advisory Committee heard evidence that only one of 6,700 children studied in the central program area since the inception of the program was positive for microfilariae by skin-snip examination. Without the OCP program, 419 children would be expected to be infected (based on pre-OCP prevalence data). This means that the three million children born since the program started have been protected from onchocerciasis infection. In addition, it is estimated that about 27,000 cases

of blindness have been prevented in Burkina Faso alone.

The June 1985 report to the Expert Advisory Committee of 10 years' results confirmed the 1984 report for the central program area of rapidly decreasing community microfilarial loads (CMFL, the mean number of microfilariae per skin-snip for the community) and microfilariae in the anterior chamber of the eye (MFAC). (Biostatistical research has demonstrated that CMFL can be used as a quantitative measure of the intensity of infection.) By contrast, in villages suffering from reinvasion, where transmission of onchocerciasis has been reduced but not interrupted, 56 infected children were found among the 2,120 examined (282 would be expected without the program), and the decreases in CMFL and MFAC were smaller than in the central zone.

Because children constitute the group least exposed to infection with onchocerciasis, they are not the most sensitive indicator of continuing transmission. Adults, whose daily activities take them closer to the rivers, are more exposed to blackfly bites. In the most highly infected (hyperendemic) villages (over 60 percent infected), all of the adults may be infected. After 8 years of vector control in the central program zone, the CMFL has decreased more than 70 percent as a result of the decrease in the number of adult worms as the older worms die. The CMFL is a more sensitive index of intensity of infection than simply measuring the prevalence of infection (percentage of infected individuals in the village). But until the last female worm dies, microfilariae will still be produced and found in skin snips.

Prevalence is decreasing slowly, but is expected to drop sharply in the next 2-3 years as the last worms (which developed from the fly bites just before OCP operations) die as they reach the age of 11 years or slightly older. (A calculation based on the rate of decrease in CMFL indicates that the average life span of the adult female worm is 11.2 years rather than the 18 years estimated at the start of the program.) Recent data support the biostatistical research prediction of a sharp drop in prevalence. In one village, for example, prevalence dropped from 90 percent to 50 percent in the last 2-year interval after falling only very slowly in the previous 2-year periods. Comparing the rate of fall of the CMFL in villages outside the control zone with that in villages in the central zone where transmission has been interrupted also gives a sensitive index of retransmission. In a reinvasion area, the CMFL was reduced by only 30 percent, showing that reinfection in adults had occurred and new worms had been introduced.

Another measure of the effectiveness of control efforts is the number of microfilariae in the anterior chamber of the eye (MFAC load). Because the degree of damage to the anterior segment of the eye has been found to be related to the MFAC load, it is encouraging to find decreases of at least 80 percent in the MFAC in the central zone. The maximum decrease in MFAC in reinvasion villages is only 40 percent.

The detailed ophthalmological surveys confirm the significance of the lower MFAC load. Of 913 individuals studied in the central area villages, 70 percent who initially had a light MFAC load no longer have evidence of eye damage. In those who initially had a heavy MFAC load, 90 percent of those with early corneal eye inflammation are now free of eye inflammation. Of those with severe eye damage recorded in the beginning, one-third have recovered completely and in one-third no further damage has occurred. Blindness occurred in only 1.1 percent of the population and was found exclusively in those who had recorded eye damage at the start of vector control.

Another result of the epidemiological surveys was the discovery of a practically linear relationship between the prevalence of blindness and the CMFL in savanna areas, whereas forest villages with heavy CMFLs did not show any increase in blindness. This finding was an important factor in the decision not to extend larviciding operations into the forest areas, except to control the breeding of savanna species in these areas.

2.2 Other Diseases

What impact has OCP had on diseases other than onchocerciasis? This question is difficult if not impossible to answer because the mandate of the OCP epidemiological evaluation teams was to collect data only on onchocerciasis. The data sheets for detailed evaluation examinations have no computer codes for diseases other than onchocerciasis and trachoma. For baseline studies in the western extension areas, OCP should consider adding other major disease categories to the epidemiology evaluation forms used in detailed village evaluations. The data should then be entered into the data bank so that no further opportunities are lost for epidemiologic surveillance of other diseases.

Data on height and weight measurements could be analysed for indications of changes in nutritional status. Otherwise, we are dependent on anecdotal evidence from interviews with village chiefs and others. The team heard statements of generally positive health impact from two village chiefs.

There are also certain possible ill effects on human health that result from interruption of the transmission of onchocerciasis and resettlement of the area. For example, 50-100 cases of human trypanosomiasis are reported each year in Burkina Faso. The World Bank will fund two mobile teams to diagnose and treat the disease which is found in workers returning from areas of endemic foci of trypanosomiasis in the Ivory Coast. Evidence of limited local transmission has been found, and the teams will be organized to prevent potential outbreaks of trypanosomiasis during resettlement of the river valleys, since the tsetse vector of trypanosomiasis also inhabits the river valleys. Schistosomiasis (bilharzia) is also a potential threat in water catchments, dams, and irrigation projects in resettlement areas.

3. RESEARCH ON HOST AND PARASITE

3.1 Research on the Forest Blackfly

A major research question for OCP is to determine whether the forest blackfly vector actually does transmit blinding onchocerciasis. Recent preliminary data from the forested lower Sassandra and lower Comoe Rivers indicate that in the northernmost villages blindness occurs in the same proportion of the population as would be expected in savanna villages with similar community microfilarial loads. The major vector is the forest type, S. soubrense, but low densities of the savanna vector, S. damnosum, are also present. These data need confirmation in further surveys, and these villages will be priority areas for research on methods to differentiate forest from savanna parasites (see Section 3.4). Differentiation of these parasites would facilitate studies to determine the potential of S. soubrense for transmitting the savanna type of onchocercal parasite.

3.2 Epidemiological and Biostatistical Research

The epidemiological evaluation unit has planned a workshop for early 1986 to provide the opportunity for an international group of expert epidemiologists to confirm OCP's internal validation of its epidemiologic methodology and to assess the epidemiologic plans and research proposals. These discussions should include consideration of whether present methods of skin-snip counts of microfilariae will serve satisfactorily for the final surveillance phase during and after devolution, when only a very low intensity of infection is expected to be encountered. The operational implications of the possible introduction of a more sensitive test should also be discussed.

The goal of perfecting a mathematical model by 1987 for onchocerciasis transmission is an important research initiative. It promises to produce a resource that will help in selecting the appropriate and least costly control strategies during and after the devolution phase, including the use of chemotherapy and of a simple, specific immunodiagnostic test when it becomes available.

3.3 Chemotherapy Research

Chemotherapy research is encouraged, coordinated, and evaluated by a special scientific working group. The group was established as a Joint Scientific Committee using mechanisms developed by the U.N. Development Program (UNDP)/World Bank/World Health Organization's Special Program for Research and Training in Tropical Disease (TDR) to organize and manage international

research on the development of new drugs. Through collaboration with Merck, Sharp and Dohme, a promising single-dose drug to kill microfilarae (Ivermectin) is in advanced trial stages in over 300 individuals. Initial results are encouraging. The disappearance of skin microfilariae with use of Ivermectin does not appear to be associated with the severe reactions (Mazzotti reaction) that have prevented widespread use of the presently available microfilaricide, diethycarbamazine. There is even a suggestion that Ivermectin may cause the embryonic microfilariae to be resorbed in the female adult worm instead of being released to travel to the skin and eyes. If this is confirmed, the drug would be even more valuable. In collaboration with Ciba-Geigy, a new drug (CG 6140) which has successfully passed animal screening tests is in the first stages of clinical trials for safety and efficacy at the testing center in Tamale, Ghana. This drug has potential for killing the adult worms. Not only is laboratory research underway, but developmental research in collaboration with pharmaceutical companies is also being carried out in many countries.

The review team visited the 26-bed Onchocerciasis Chemotherapy Research Center in Tamale, Ghana, which is carrying out a 3-month assessment of different dosages of Ivermectin. The director, Dr. K. Awadzi, and all his staff are Ghanians. Their salaries are paid by the Government of Ghana, which also provides free hospitalization for individuals admitted for chemotherapy trials. All other expenses are covered by the OCP or TDR budgets. Dr. Awadzi was finishing the 3-month assessment of various Ivermectin dosages (given in a single dose) in 152 individuals, in a comparison with diethycarbamazine. The Center is informed about other Ivermectin trials sponsored by Merck in Togo, Mali, Liberia, Ivory Coast (Bouake), and Senegal (Dakar). The goal is to assess chemotherapeutic efficacy in the shortest time possible using a system of multicenter trials following a single protocol. Dr. Awadzi's ability and long experience should be utilized to the fullest to coordinate studies in each trial area to ensure compliance with the protocol.

If, as is hoped, Ivermectin becomes available for use in 1987, OCP will need to consider the best strategy for incorporating this new potential control measure in its program. The following questions need to be answered: how will the drug be delivered to the population; will everyone at risk be treated or only those diagnosed as having onchocerciasis (a more complicated task); and what will be the cost of systems to deliver the drug to all villages in the program regions of the seven countries?

3.4 Immunology and Molecular Biology Research

There are two major topics for research related to immunology and molecular biology:

1. Development of a simple, sensitive, and specific

immunological test for recent infection with onchocerciasis. Immunological techniques, alone and in combination with genetic engineering techniques, are beginning to be explored in connection with a project to produce third-stage (infective) larvae in the laboratory.

2. Differentiation of parasite strains. Promising preliminary results have been achieved on differentiation through iso-enzyme studies, and these tests are continuing. Arrangements also have been made to explore promising techniques for DNA analysis of the parasites. In addition, immunological techniques (monoclonal antibodies) should be utilized for research.

These results and plans were discussed at a meeting of the UNDP/World Bank/WHO TDR Filariasis Scientific Working Group held in Bamako, Mali in November 1984. In view of the successful use of the special scientific working group for chemotherapy research, OCP should consider organizing a Joint Scientific Committee in collaboration with TDR to manage the basic and applied research needed to develop the simple, sensitive, and specific immunological tests required for early diagnosis of onchocerciasis in children. An OCP Immunology and Molecular Biology Scientific Committee could also manage and evaluate the research for differentiating forest from savanna onchocercal parasites in order to develop a simple technique for detecting onchocercal larvae in the fly. In addition, consideration could be given to the two longer term problems of developing a vaccine for immunization against onchocerciasis and of obtaining a better understanding of the pathogenesis of eye lesions in order to learn how to stop the progression to blindness.

4. IMPACT OF OCP ON DISEASE CONTROL POLICY FORMULATION

4.1 National Health Planning

Now that planning for integration of onchocerciasis control into primary health progams has begun seriously, the potential for OCP to promote national primary health care programs and other health planning initiatives should be explored in more depth. Several guidelines for national health planning can be derived from the successful experience of well-managed, regional or global vertical disease control programs such as OCP and the earlier WHO Smallpox Eradication Program in mobilizing national health efforts in order to reach their goals.

Throughout its history, OCP has supported national health programs in several ways. For the most part, it has concentrated on training nationals in the disciplines required for onchocerciasis control. OCP has also contracted with the Organization for Coordination and Cooperation in the Campaign Against Endemic Diseases (OCCGE) for a schistosomiasis training program. The OCP Public Health Adviser has responded to requests from national Ministries of Health to work with them in planning

immunization campaigns, and the OCP Director in collaboration with WHO, offered emergency help during a yellow fever epidemic.

OCP should continue to take advantage of its unique potential to demonstrate that a successful and effectively managed vertical program can be used to help member countries with the operational research needed to develop effective national primary health programs. The epidemiological evaluation unit could assess the feasibility and cost of using the epidemiologic teams during devolution to train nationals for surveillance of other health problems (multidisease surveillance) in the villages. Participating countries require more of this kind of information to help them identify priority needs for primary health care. Other pilot operational research projects could include the training of village health workers to help develop national infrastructure for primary health care. These OCP activities to strengthen national primary health care programs should be developed in collaboration with WHO's primary health supporting activities and with UNICEF's and WHO's immunization programs.

The June 1985 Expert Advisory Committee requested WHO to work with OCP to identify feasible, clear-cut goals for primary health care. The Committee also recommended that specific research and development be carried out in cooperation with the local health authorities for evaluating epidemiological techniques, field testing an immunodiagnostic test (when available), and trying different delivery systems for drugs. However, care must be taken in implementating these recommendations so that OCP's efforts toward the major goal of onchocerciasis control are not dissipated.

There appears to be a growing sentiment among participating countries, donors, and sponsoring agencies for retaining the impetus of this well-managed vertical health program but to shift it into the wider context of national health and development. With devolution already underway, OCP is training and supervising national teams in the western extension and facilitating the integration of onchocerciasis control into primary health at the village level. Now is the time for serious discussions to begin among participating countries, donors, and multilateral agencies on how to retain the gains made by the OCP in the area of intersectoral collaboration for health and how those gains can be extended to help the participating countries strengthen their primary health care programs.

4.1.1 Intersectoral Collaboration for Health

OCP will be presented as a prime example of intersectoral collaboration for health during the 1986 World Health Assembly discussion on "The Role of Intersectoral Collaboration for Health for All." The combination of national participation through National Onchocerciasis Committees (see Appendix D) in a dramatically successful disease control program and the focused

attention of important donor countries and sponsoring multinational organizations confers a special status on OCP in the participating countries.

OCP helicopters fly freely not only within each country but also across national boundaries. Travel in OCP vehicles through numerous checkpoints and across national borders is accomplished without the usual frustrating delays. At a higher level, the Director of OCP has ready access to and has recently met with the Presidents of Burkina Faso, Ghana, Ivory Coast, and Guinea. These discussions have also involved the Ministers of Health, Finance and Planning, and other relevant ministries. Presidential support has been given to Ministry of Health plans for developing onchocerciasis surveillance components for primary health care at the village level.

4.1.2 Working Group on Devolution

In 1982, when it was evident that interruption of disease transmission was proceeding successfully, a Working Group on Devolution met to consider the recommendations of the 1981 WHO Independent Commission Report, which stated that "Devolution to participating countries should begin with epidemiology evaluation teams and continue with vector surveillance after the maintenance phase is reached."

The seven-country Working Group has met annually since it inception. At its April 1985 meeting, the Working Group discussed the creation and training by OCP of national teams for epidemiologic and entomologic evaluation, training and "recycling" of technicians, and sensitizing the population and national administrative structures to onchocerciasis surveillance issues. The Working Group also requested that a tripartite team (OCP, WHO, and a national expert) visit each participating country to help prepare realistic national programs of integrated primary health care that include onchocerciasis control. The OCP Director, in collaboration with WHO/Brazzaville, is assembling the teams with nationals from the participating countries who will later be responsible for developing and carrying out primary health care programs in their own countries.

4.1.3 The Burkina Faso Plan of Operations for Devolution

At its April 1985 meeting, the Working Group also discussed the Plan of Operation for Devolution presented by Burkina Faso. Because Burkina Faso was the first country entirely in the maintenance phase of vector control operations, its plan of operations was the first to be prepared in detail. Its format was approved for use in preparing the plan of operations for the other participating countries. The Burkina Faso plan includes an introduction on the Government policy decision regarding primary health care; a discussion of the health problems and priorities

in the OCP areas, including the number of village health workers and the program for training additional workers; a description of long- and short-term goals and the human and financial resources required to achieve them; and presentation of a provisional calendar.

The long-term goal of the Burkina Faso plan is to train and equip one village health worker and one midwife to operate each of the projected 7,492 Primary Health Posts (1,124 currently exist). Their support network will consist of the projected 579 Health and Social Promotion Centers (48 exist), 69 Medical Centers (39 exist), and 10 regional hospitals (5 exist). The short-term goal is to train and equip one village health worker and one midwife for each of the 116 OCP villages in Burkina Faso. The program would be structured as an operational research project on the participation of village health workers in health promotion, including onchocerciasis surveillance using Bellac traps and other methods. Thirty mobile polyvalent regional epidemiologic teams are also proposed, to work closely with the OCP sectors and subsectors. OCP is counted on for training (and as a source of trained nationals for the regional teams and the Medical Centers). The Medical Centers will perform the parasitological examinations required for surveillance of onchocerciasis and other endemic diseases.

The devolution process as it occurs in Burkina Faso will offer the opportunity to see how successfully responsibility for surveillance and maintenance of onchocerciasis control can be transferred from the large-scale OCP effort to a national-scale based on village primary health workers and a smaller number of epidemiologic surveillance teams.

4.2 Regional Cooperation and the Intercountry Facility

The annual meetings of both the National Onchocerciasis Committees from participating countries and the Working Group on Devolution have stimulated national planning for OCP's stated goal of devolution and have promoted the integration of onchocerciasis control into national health structures. These meetings provide opportunities for the regional exchange of ideas and agreement on policies related not only to onchocerciasis but to other areas of regional health and development as well.

In 1981, the Independent Commission recommended that

> Once a maintenance phase is established, perhaps 10 years from now, vector surveillance and whatever vector control activities are necessary should be devolved. The OCP will then gradually diminish so that, after a further period of about 5 years, it is established as an inter-country coordinating surveillance centre working with national teams who will also broaden their activities to encompass other endemic diseases.... While the central area is moving into a maintenance phase, there will still be areas in the west

where large scale vector control is required. Thus, one part of the central OCP would be expanding from dealing only with onchocerciasis to analyzing data, advising on action and providing technical assistance and training for the surveillance and control of other diseases, while another part would be continuing with large scale aerial operations. These two activities will require different types of staff, and very good management will be necessary to keep these two activities running in parallel during this intermediate phase. However, we have no doubts that this two-pronged activity can be run successfully (WHO August 1981).

At the third meeting of the Working Group on Devolution in 1984, all participating countries indicated a need for an intercountry facility that would function at the end of OCP's mandate as an instrument for coordination and intervention, operational research, information dissemination, and planning. The June 1985 Expert Advisory Committee also reiterated its conviction that an intercountry facility should be developed, although the Committee indicated that OCP would perform this function for the near term.

APPENDIX C

SOCIOECONOMIC IMPACT

by Antoinette B. Brown and Larry Dash

1. SETTLEMENT AND HUMAN ECOLOGY ASPECTS OF ONCHOCERCIASIS

Epidemiological studies conducted in the Onchocerciasis Control Program (OCP) region showed that individuals and communities living under the same apparent conditions of transmission exhibited different clinical manifestations according to the size and location of the village, the density of the population and its housing patterns, agricultural practices, and professional activities.

Before the program began, it had been noted in Burkina Faso that the level of endemicity in a village depended on its proximity to the blackfly breeding site. Yet two communities equidistant from the breeding sites could display very different levels of endemicity according to whether they were in the "front line" or whether other settlements came between them and breeding sites, attenuating the risks of transmission. In short, severity starts to decrease from the front line of settlement, whatever its distance in relation to the river breeding site (Rolland 1975). In Ghana (Hunter 1966) and Mali (Lefait 1976) it had been observed that communities moved away from the rivers when onchocerciasis became intensified and then moved back when the situation seemed better.

It was noted in Ghana and in Burkina Faso that blindness

rates of over 5 percent were in general found in villages of 200 inhabitants or fewer, whereas they were exceptional in settlements with 500 or more inhabitants. Furthermore, there was no population growth in the communities where the blindness rate equaled or exceeded 5 percent (Hughes 1949, Hervouet and Prost 1979, Prost et al. 1979). There is an interaction between these two phenomena. The risks of blindness reduce the population through the departure of young members and the premature death of blind persons. Hence, those who remain suffer an increased rate of infection because the number of biting blackflies in the area of a village remains relatively constant. Conversely, there appears to be a critical population mass above which transmission of the parasite is diluted among a larger number of individuals and no longer possesses sufficient intensity to cause a high rate of blindness, which is proportional to the number of accumulated infections (WHO, OCP 84.3).

An analysis conducted in Burkina Faso showed that one of the factors governing the severity of onchocerciasis was the population density in the part of the village land area effectively utilized. Generally speaking, when the population density is over 50 inhabitants per square kilometer, the blindness rate remains below 5 percent even in front-line villages in hyperendemic zones; their demographic pattern is identical to that of unaffected communities. In contrast, in settlements equally exposed to the disease, but where the population density is below 35 inhabitants per square kilometer, the blindness rate exceeds 5 percent, the social fabric disintegrates (e.g., uninfected individuals tend to leave the village after a critical level of ocular involvement occurs in older adults), and population growth falls below 1 percent (Hervouet and Prost 1979, Prost et al. 1979).

Spontaneous or organized migrations into Burkina Faso valleys under control result in an effective population density generally below 35 inhabitants per square kilometer. The migrants practice extensive farming which is facilitated by the development of individual means of transportation. Little attention had been given to this phenomenon until the socioenconomic report of the western extension zone, which recommends that settlement plans be considered in terms of intensive cultivation and human groups (ORSTOM 1984). The report points out that intensive agriculture in West Africa can support 80 inhabitants per square kilometer (Pelissier 1966).

It was also demonstrated in Burkina Faso that the blindness rate varied noticeably among ethnic groups living side by side but having different space occupation systems (Paris 1980, Prost and Paris 1983). Each settlement contains two areas of economic activity: the peridomestic zone (residential space, permanent fields, and water points) and the external agricultural areas. The degradation of the plant cover and the elimination of plots in the peridomestic zone discourage dispersion of the vector. In addition, the concentration of the population into a limited space reduces individual contact with the vector -- the vector avoidance phenomenon. On the other hand, the external

agricultural areas (the more distant temporary fields, fallow land, the ground transversed in livestock tending and wood collection) are conducive to circulation of the vector. Human contact with the vector is particularly intensive in isolated land parcels (WHO, OCP 84.3). The movements and distribution of the population between the two spaces effect the severity of onchocerciasis.

In the region of the Bougouriba in Burkina Faso, the Lobi have a very dispersed habitat which eliminates the phenomenon of vector avoidance of the villages. The Lobi practice extensive farming in the external area, and their blindness rate is over 5 percent. The Birifor and the Dagara are grouped in compact villages on hillsides or in the areas between the rivers. They practice intensive agriculture in the peridomestic area and work communally, which reduces the time spent in the fields. The low ground has been parceled out into rice paddies, eliminating the ground cover and the galleries. Their blindness rates are far lower than among the Lobi. These communities have developed a true social mechanism for resistance to onchocerciasis (WHO, OCP 84.3).

Those who work near the rivers, such as fishermen, rice growers, and ferrymen, are particularly exposed to the risk of onchocerciasis. However, unambiguous conclusions cannot be drawn. For example, rice growing is a high-risk activity in Sierra Leone (White et al. 1983) and the Ivory Coast (Senoufo region), where it is practiced in the vicinity of the permanent rivers. In the Dagara region of Burkina Faso, however, it actually contributes to reducing the dispersion of blackfly through the destruction of the plant cover (Prost and Paris 1983) and hence to limiting the spread of of the parasite.

Women are, in general, less heavily infected than men because of the gender-based division of labor. This is true in Burkina Faso among the Lobi and Birifor, where the women farm only the peridomestic area whereas the men farm the external area. Among the Dagara, on the other hand, where women share the same tasks as men, they exhibit the same rates of infection as the men (Prost and Paris 1983). Among the Senoufo in the Ivory Coast, where only the women practice rice growing, they are more heavily infected than men. Farming with draft animals or using mechanized equipment reduces the working time in the fields and hence exposure to the vector. The provision of village wells and pumps also reduces the exposure of women and children who otherwise use the rivers for bathing, washing clothes, and collecting water for domestic purposes.

Research into human ecology has brought to light a range of social determinants of onchocerciasis endemicity. Although this information suggests possibilities for organizing space from an epidemiological point of view, it is not clear that a pattern of development meeting the requirements of onchocerciasis prevention is economically or socially possible or desirable.

2. ECONOMIC IMPACT OF THE ONCHOCERCIASIS PROGRAM

The tangible economic benefits of the control of onchocerciasis result from improved human productivity and access to natural resources. The disease syndrome includes varying degrees of blindness, disability, and debility that greatly reduce the work capacity of victims. The Onchocercaisis Control Program has been able to prevent infection and thereby to protect against blindness, impaired vision, and the sapping physiological aspects of the disease. In addition, by reducing or removing the blackfly, the OCP has reduced the nuisance effect of their biting which hampers work performance in the countryside, particularly near breeding sites. Reduction or elimination of the disease, the threat of disease, and the vector itself have helped to open up large areas of underexploited land resources, thereby increasing production opportunities for agriculture, minerals, pasture, and woodlands. The OCP area encompasses some 764,000 sq km (1985) and 15 million people, giving an average population density of only 20 per square kilometer. This ratio suggests underutilization, even without consideration of the quality of the land.

2.1 Global Economic Effects

2.1.1 Land Use

The 1978 Report of the Economic Review Mission states:

> The Program would help make available some 276,000 km(sq) of land of which some 134,000 to 154,000 km(sq) would be suitable for agricultural purposes. [However,] the concept of arable land is imprecise. ... There are a number of factors ... which may present serious obstacles to productive utilization of "new land" in the OCP area. Some have to do with soil and topographical characteristics, others with medical hazards and perhaps others yet unidentified also exist. All are constraints in an economic sense, since their removal may require substantial resource costs (WHO, OCP 78.2).

We know also that political conditions, population pressures, and economic opportunities vary considerably among the countries of the OCP area. The coastal countries -- Benin, Togo, Ghana, and Ivory Coast -- developed economically in the forested areas closer to their coasts while the interior lands were, and continue to be in some cases, relatively neglected by investors and less attractive to settlement. But in the Sahelian countries of Niger, Burkina Faso, and Mali, the areas of endemic onchocerciasis coincide with some of the best-watered and potentially productive agricultural land in the territory. (Most of Burkina Faso is in the formerly onchocerciasis-endemic zone.) In the Sahelian countries, the pattern of use and development is

therefore in sharp contrast to that in the coastal tier. Even though an additional development initiative will be required to bring these new lands into production, and some of this area may never be exploited, an evaluation of the potential production of these areas is crucial to an assessment of the impact of the OCP.

An order-of-magnitude estimate of the yield of the 150,000 sq km of agricultural land located in the 800-1,000 millimeters per year rainfall zone and tilled with traditional technology (two-thirds fallow, hand-hoe, family farms) would be an average of 800 kilograms per hectare (ha) of sorghum per year.

The total potential output{1} would be:

Surface tilled: 25,000 sq km = 2,500,000 ha
Average yield: x .800 metric tons (t)/ha
Total yield = 2,000,000 t

Because an average family of 10 requires 2 tons of cereal grain per year (200 kg per capita), the potential output under traditional conditions could feed 1 million families or 10 million people. For individual countries, development of unexploited lands could contribute significantly to aggregate production (see Table C-1).

Table C-1. Potential Production of New Lands Using Traditional Cultivation

Country	(A) New Tillage (million ha)	(B) Potential Production (million t)	(C) Current Production	B/C
Benin	0.30	0.24	0.32	0.75
Ghana	0.75	0.60	0.41	1.46
Ivory Coast	0.35	0.30	0.39	0.76
Mali	0.55	0.44	0.70	0.63
Niger	0.01	0.01	1.70	0.01
Togo	0.05	0.04	0.27	0.15
Burkina Faso	0.45	0.35	0.97	0.36
Total	2.46	1.98	4.76	0.42

Source: Derived from Joint Program Committee (OPC/JPC 5.7), December 1984 p. 15.

Liberation from the threat of onchocerciasis and the nuisance of the blackfly attracts immigration to the onchocerciasis-freed zone. Economic and population pressures in the communities outside the onchocerciasis-zone and government encouragement are additional incentives to migration. Despite these inducements, however, the rate of population growth for the first 10 years is

not significantly different in the zone than it is in the other areas of participating countries (see Table C-2).

Table C-2. Population Growth Rate in the Onchocerciasis Program Zone of Participating Countries

	OCP Zone Population (millions)		Average Annual Growth Rate (percentage)	
Country	1970-1971	1984	OCP Zone	Country
Benin	0.6	1.1	2.8	3.1
Burkina Faso	4.9	6.0	1.9	1.9
Ghana	1.6	2.4	2.8	2.6
Ivory Coast	1.0	1.9	1.7	4.2
Mali	1.4	3.6	2.5	2.5
Niger	0.09	0.1	3.3	2.8
Togo	0.6	0.8	2.0	2.9

Source: Preliminary data, OCP Socioeconomic Development Unit.

The urgency of the need to exploit the potential production of the zone varies in each country from insignificant to critical. Table C-3 presents the potential population carrying capacity at a minimum subsistence level for an agriculturally based economy in the liberated areas. For Burkina Faso, where population pressure is perhaps the greatest among the participating countries, the absorptive potential of the liberated lands represents about 15 years of the national population growth. In Mali, the freed area could accommodate 22 years of the current population increase. On the other hand, the absorptive potential of liberated areas in Niger is negligible.

Obviously, this analysis is oversimplified. It is presented here to identify some easily understood, conservative, and not implausible aspects of the potential production of the onchocerciasis-freed lands.

Table C-3. Population Capacity{a} of Liberated Land in the OCP Zone (millions)

	(A) OCP Zone Capacity	(B) Present Total Population	A/B
Country			
Benin	1.1	3.5	0.31
Burkina Faso	1.2	7.0	0.24
Ghana	2.9	12.2	0.24
Ivory Coast	1.4	9.6	0.15
Mali	2.2	7.8	0.28

Niger	0.01	6.2	0.01
Togo	0.25	2.9	0.01

{a} Assumes a subsistence level of annual production of 800 kg/ha of food grain for a family of 10 cultivating 21/2 ha.

{1} The calculation assumes an averge 6 years of fallow following 1 year of use. An alternate estimate of 1.6 ha per capita to feed one average individual yields about the same result.

2.1.2 Productivity

Decreasing the incidence of onchocerciasis and the nuisance of the blackfly will increase the productive potential of the population. Those who have been weakened or blinded by onchocercisais obviously have impaired productivity. The nuisance factor of biting blackflies also affects productivity among those free of onchocerciasis, sometimes cutting as many as 4 hours from the workday as people abandon the blackfly zones during peak biting hours. A socioeconomic study for the OCP extension area estimated the productivity effects of the disease and the blackfly nuisance (ORSTOM 1984) (see Table C-4).

The direct productivity loss was estimatd at about 5 percent of the capacity of an exposed workforce of one million workers. This would be equivalent to a production loss of about 10,000 tons of food grain. Assuming a 1984 population in the program area of 15 million people, of whom 70 percent are in the productive age range, the potential work loss attributable to the disease amounts to less than 0.1 percent of the total potential productivity of the OCP area population.

Table C-4. Reduction in the Physical Capacity To Work Resulting From Onchocerciasis and the Blackfly

	People Affected		Annual Person Days Lost{b}	Total Potential Work Loss
Effect	Percent{a}	Number	(millions)	(percentage)
Blindness	1.25	12,500	2.5	1.25
Sickness	5.0	875,000	3.5	1.75
Nuisance	5.0	875,000	3.5	1.75
Total			9.5	4.75

{a} Percentage of exposed population affected or percentage of work time lost by exposed productive population.

{b} Assumes a work year of 200 days.

2.1.3 Conclusions

This examination of the major aggregate potential output effects of onchocerciasis and blackfly control employs very conservative estimates of relevant parameters to avoid exaggeration of benefits or losses. The computations indicate that a successful onchocerciasis control program would eliminate the threat of onchocerciasis and the nuisance effect of the blackfly as an obstacle to development of a surface area that could yield 2 million tons of food grain annually. At the same time, the program would help to restore (or avoid future loss of) productive capability amounting to an average of about 5 percent of the output potential of victims of the disease and the fly. If one accepts this latter computation as broadly illustrative of the minimum direct production impact of the program, then it seems clear that onchocerciasis does not greatly impede aggregate country production.

What is significant, however, is the potential production (2 million tons of grain annually) that could flow from the unexploited lands. While the failure to exploit these lands cannot be attributed solely to the blackfly nuisance and onchocerciasis, the control of the disease certainly advances the possibility of production. This is the significant economic impact of the program: the potential that is liberated.

2.2 Other Benefits and Costs

OCP has provided training and employment for hundreds, improved logistics and communication in the program area, improved health and hygiene services, and augmented knowledge of the zone's natural resources. The successful control of the disease has not only directly improved the health and the prospects of improved health of hundreds of thousands of inhabitants, it has also helped ensure social and cultural stability and continuity. The success of the program has expanded alternatives available to populations and resources under pressure and thereby has improved the security of individuals and nations. No attempt will be made here to quantify these benefits in objective terms.

The cost (disbursements) of OCP was approximately $158 million for the period 1974-1985. Other, unquantifiable costs include soil, water, and environmental degradation resulting from the exploitation of new lands and the use of chemical insecticides and larvicides. There also may be increased incidence of some diseases because of increased exposure to previously avoided waters, riverine areas, and irrigation works.

Prost and Prescott (1984) examined the cost-effectiveness of the OCP approach to blindness prevention. They computed the cost per case of blindness prevented in terms of the disability and premature death that would have resulted from onchocerciasis during the 20-year span of the project. The analysis yields project cost{2} estimates of $20 per year of productive healthy life added and $149 per discounted year of productive healthy life. (Because blindness caused by onchocerciasis occurs in the middle-age productive years, all years of life added by OCP are considered productive years. This is a crucial distinction when making comparisons with alternative health interventions. For example, discounted costs per productive year added by measles immunizations were estimated between $190 and $221.) Given that average minimum production per farm worker is one-quarter ton of cereal per year, equivalent to $50 at current world prices, the discounted (at 10 percent) present value of the average production per farm worker in the program area over a 20-year period would be $196. Thus, if, for example, 100,000 cases of blindness are prevented through the OCP, the potential value of the production of those workers is $19.6 million.

{2} A potentially low-cost methodology may be derived from the experience in the Dogon Plateau in Mali. Here the population, in excess of one-quarter million, is culturally homogeneous and traditionally independent and self-sufficient. The blackfly problem has a 6-month season because most streams disappear during the dry season. OCP undertook an experiment in devolution to give the Dogon responsibility for some of the control operations, under the leadership of one of the OCP staff in Bamako, himself a Dogon. The experiment worked very well; the people have demonstrated that, with some training, they can capably perform the tasks of larvae discovery and identification, catching, and probably larviciding. While there are many skeptics, some experts in the field believe that the experience in Bandiagara can be expanded and duplicated elsewhere and lead toward a high degree of self-reliance for much of the program. This seems a likely and attractive possibility after the control program is completed and the maintenance phase is established.

2.3 Global Parameters

Although the costs and outputs of the project do not lend themselves easily to standard analysis, some attempts were made in the Economic Review Mission (WHO, OCP 78.2) evaluation report. These will be examined briefly. The report considered the value of income lost due to disease and aggravation, but it took no definitive position because of the paucity of data and the impossibility of isolating the effects of the disease. The report generated calculations of the present value of lost output, which varied (at 1978 prices) from $20 million to $94 million depending on the discount rate (10 to 15 percent) chosen and the value of the marginal product of labor. The report observed (App. II, p.8) that because the life-of-project effects

can be expected to extend for as many as several generations and some may even be irreversible (e.g., the disease will not resurge), lower discount rates and longer time horizons may be more suitable for evaluating OCP than conventional assumptions (10-15 percent and 25 years, respectively). The use of longer time horizons (50 years, for example) and a 9-percent discount rate brings benefits above costs (present values). The use of a very low discount rate (which values the welfare effects on the next generation almost as highly as those on the present generation) brings the present value of OCP benefits to over twice the present value of OCP costs with a 50-year time horizon.

The report then examines benefits that might flow from exploitation of the new lands (p. 9). These benefits are the net summation of (1) the value of output, (2) decreased soil degradation of old lands left by the settlers, minus (3) the value of output lost because of emigration from old land, (4) moving costs, and (5) other investment costs. The report did not attempt to calculate these benefits, but noted that the critical estimates, those for complementary investments, depend on the types of settlement (organized or spontaneous). Using a 10-percent discount rate, the cost (1972) of the program was estimated to range from $154 to $227 million, depending on its length, and the labor-related benefits were estimated to range from $32 to $94 million. So for benefits to equal costs, the average annual flow of new lands benefits would have to be $6.6-$20.8 million. The need for longer time horizons applies with particular force to new lands benefits. The report noted that both the slowing down of erosion on old lands and the opening of new lands are clearly long-term effects, which may warrant a higher valuation of future benefits than is implicit in the conventional discount rates.

This review does not attempt to carry the above analysis further. The gross order-of-magnitude calculations presented in Section 2.1 are designed to give the reader a more tangible measure (i.e., food production) of potential benefits (and costs) of a successful OCP. It is understood, of course, that the full costs of exploiting this potential would be well beyond the means and the mandate of OCP.

3. INDIRECT IMPACTS

3.1 Socioeconomic Planning

The OCP has played a positive role in stimulating socioeconomic planning through the activities of its socioeconomic development unit, its epidemiological unit, and the planning units within participating countries. The role of the OCP socioeconomic development unit is to collect baseline data in cooperation with the participating countries; to carry out data analyses necessary to establish meaningful trends and to draw valid conclusions; to ensure the dissemination of this information to the participating countries and to share

information and experience; and to identify opportunities for donor collaboration in socioeconomic development (OCP/JPC 5.6).

The OCP Joint Program Committee recommended that the socioeconomic development unit, in close collaboration with the participating countries, undertake a global study of the impact of OCP activities on socioeconomic development, population movement, land occupation, productivity, and needs for technical and scientific assistance. In response, the unit developed a series of district-, village-, and household-level questionnaires to assist the participating countries in collecting comparable data. The majority of countries have already submitted draft results to the socioeconomic unit for analysis. The reports are largely compilations of existing and projected development projects within the onchocerciasis-freed zones of each country. Not all report comparable data, and none of the drafts documents the extent of spontaneous migration and consequent production and land clearing.

The level of staffing for the socioeconomic unit presented in the plan of operations for the Third Financial Phase, 1986-1991 (three professionals and two general service posts for 1986/1988, and only one in each category by the end of Phase III) does not seem adequate for the enormous task of examining the socioeconomic impact of the OCP, particularly given the varying levels of expertise and cooperation in participating countries. This monitoring process should be implemented through village-and household-level interviews in all participating countries and high-resolution aerial photographs.

The epidemiological unit is also supporting socioeconomic development planning in the onchocerciasis-freed zones through the collection and analysis of epidemiological data on mortality and nutritional status, and through the creation and testing of a primary health care questionnaire survey designed to be carried out by village workers.

A socioeconomic survey of the proposed western extension has been prepared by ORSTOM as part of the feasibility studies for that area (ORSTOM 1984). This information will be useful as a baseline data bank for later monitoring, as a catalog of human and community resources for program implementation, and as a basis for planning additional socioeconomic projects that will complement OCP activities. In the extension areas, participating countries will be encouraged to undertake socioeconomic surveys to establish a pre-OCP operation baseline which will allow for continuing evaluations using simple, standardized socioeconomic indicators. The countries concerned will thus be able to identify more clearly the activities required for supporting planned and spontaneous community development in onchocerciasis-freed zones. The OCP reports that it will provide technical backstop-ping whenever required. However, it is difficult to see how the projected socioeconomic unit staffing will be adequate to provide this assistance.

The OCP has indirectly assisted national governments in their

individual planning efforts for the OCP area. An interagency meeting of the U.N. Development Program (UNDP), the World Bank, and the Food and Agriculture Organization (FAO) was held in December 1974 to devise a basic planning methodology. To implement the methodology, a Development Planning Group, headed by a permanent adviser, was to be attached to each OCP country's planning agency. Five of the seven participating countries agreed to the general approach outlined in the methodology. The Ivory Coast and Niger preferred to channel their efforts through their existing regional approaches. Implementation of the methodology was estimated to require approximately US$7 million.

The UNDP, the World Bank, and AID offered support for various components. The UNDP made available US$500,000 over a 3-year period for the conduct of the socioeconomic studies by the five participating countries (Benin, Ghana, Togo, Mali, Burkina Faso) that had agreed to the proposed methodology. Implementation has been uneven. It is apparent that the nature and purpose of the planning methodology has given rise to different interpretations in the participating country governments. Because countries differ in key respects, a uniform approach to their devel-opment is inappropriate.

The Joint Program Committee has noted with satisfaction the accelerating progress being made in resettlement and development of onchocerciasis-freed areas. This progress emphasizes the need to promote those aspects of socioeconomic development, such as increased community participation and the improvement of primary health care, that are important for the successful devolution of responsibility of the control program.

3.2 New-Lands Development

The development of the onchocerciasis-freed zones is not a responsibility of the OCP. The OCP does cooperate with country-initiated efforts by monitoring development and providing information on hygienic, biological, and socioeconomic conditions in the zone. The Joint Program Committee has stressed the importance of integrating settlement schemes more effectively into national programs for social and economic transformation.

The development of new lands opened through onchocerciasis control has taken place both within the framework of planned projects and through a variety of spontaneous, unsupervised mechanisms such as repopulation of abandoned villages, utilization of land for pasture, and spontaneous settlement by family and friends of residents or by individuals attracted by commercial enterprises. Some countries have launched organized settlement campaigns whereas others include the zones within their nationwide planning and development apparatus.

Planned schemes have promoted substantial new settlement, particularly in Burkina Faso which created a special agency, the Volta Valleys Development Agency (AVV), to develop the

onchocerciasis-freed zone. Various donors have supported this activity, whose original objective was to settle 65,000 families over 20 years. Between 1973 and 1985, 3,370 families comprising 26,659 people have been settled into 67 villages. Some 12,000 hectares are under cultivation (Government of Burkina Faso 1985).

The AVV experience has demonstrated the feasibility of organized settlement, but it has also encountered unexpectedly high investment costs. Other authorities have attempted less costly approaches, which require a larger contribution from the settlers themselves. AVV has formulated a new development policy that will ensure greater settler participation in the creation of village infrastructure such as roads and schools and that requires settlers to cover the costs of moving. This new policy is intended to increase settler participation, organization, and training and reduce the cost of infrastructure.

Exploitation of the onchocerciasis-freed areas can be a very complex undertaking, involving physical access, private and official investment, community disruption, juridical issues, cultural change, and acquisition of new technologies. The OCP itself has had a positive impact on access and communication by removing barriers to population movement (construction of some access roads) and by providing opportunities for understanding the physical nature of the terrain and resources. The network of new roads has enhanced the settlers' opportunities to diversify their income by seeking markets for their products and by facilitating the movement of people within the region who are seeking wage labor. The roads are also an important factor in attracting additional spontaneous migrants to certain areas rather than others.

3.2.1 Water Resources

The OCP has removed barriers to the utilization of water resources. The control of onchocerciasis has given human populations greater access to the water resources of the Volta valleys. This enhanced access to water has created productive opportunities for irrigation and other water-management agricultural schemes. Hundreds of small dams have been built to benefit commercial projects, which add to the cash income opportunities of villagers employed by these projects. Many of the commercial programs have also associated with them the construction of numerous wells to serve villages. Similar well-drilling programs have been conducted by settlement agencies and by nongovernmental agencies as well. The benefits of increased access to water resources have also been extended to pastoralists through the construction of numerous watering points for animals.

The full benefits of improved access to water are still to be achieved. Information from villages within the program zone in Benin, Ivory Coast, Mali, and Togo show that 55 percent of the villages obtain their drinking water from the nearest river,

while 39 percent get their water from wells, only one of which is covered. In all the villages the women do the washing near the water source. This is also generally where the women and children bathe. This exposes a large part of the population to waterborne diseases (Karam 1985).

3.2.2 Organization of the Living Environment

Changes in the organization of the living environment resulting from the increased opportunities for production in the onchocerciasis-freed zones have benefited much of the population. A survey of OCP zones in Burkina Faso and Togo showed that 71 percent of the peasants in the survey reported that in 1984, as compared with 1975, there had been an improvement in their housing, either in the type of building or the building materials used (WHO, OCP/GVA 84.1).

Similar improvements have not been realized in waste disposal. A survey of the OCP zone showed that most household wastes and the excreta of small children are disposed of in the traditional manner, about 2-40 meters from the compound. This results in a series of rubbish heaps in the villages, which are scattered about by the poultry, small animals, and wind. Excreta disposal in the bush is practiced by 77.8 percent of the villages. In the other 22.2 percent of the villages, almost all families have at least one latrine, which is generally just a hole in the ground. Excreta disposal in the bush takes place at greatly varying distances from the compounds and sources of drinking water (Karam 1985).

3.2.3 Education

In most areas within the onchocerciasis-freed zones, school attendance has declined as children are needed to cultivate the greater agricultural area per family. Enrollment in primary schools in the current OCP area ranges from about 20 percent in Burkina Faso (except in the AVV region, where attendance is 174 percent of the national average), Niger, and Mali to 76 percent in Ivory Coast. Of these only 20-33 percent are girls (World Bank 1984).

Educational opportunities for adults are opening up through agricultural and home economics extension agencies, functional literacy training, and radio-transmitted instruction. One major agricultural extension agency in the area is the AVV in Burkina Faso. The AVV coordinates its agricultural education program through an intensive network of extension workers. For the first 5 years following the settling of a village, the AVV assigns one male extension agent (encadreur) for 25 families and one female extension agent (animatrice) for 50 families. After 5 years the ratio is reduced, and eventually the AVV phases out its independent activities in the area.

The encadreur is the main link between the settlers and the administration. He informs farmers about new agricultural techniques and assists them in applying the techniques. The animatrice is concerned primarily with AVV programs to promote family health and nutrition. Once admitted to the program, extension agents attend an intensive 3-month training session at one of the AVV training centers.

One criticism of the AVV extension agents has been that, because the posts are filled by a highly competitive national examination, the agents are generally from the urban centers and have had little or no rural or agricultural experience. This makes their acceptance by the settlers more difficult and their work less effective than it might be if they were chosen from rural areas on the basis of successful agricultural or domestic performance and then trained in progressive techniques.

Another criticism has been the lack of attention paid by the encadreurs to training female horticulturalists. Women are responsible for almost all production for domestic consumption and also participate in cash crop production. Despite this, they seldom receive training or access to improved inputs.

3.2.4 Land Use and Tenure

The opportunities created by the OCP have enabled many people to gain access to land for farming and grazing. Although some of the settlers have been settled by government agencies, the majority are spontaneous migrants. Some of the migrants who move from within the region retain use rights to the land from which they have emigrated. Others seek land use rights from the chief of the land they are seeking to cultivate. This permission is seldom denied as long as land is available, there are no outstanding claims on the parcel, and reasonable use is to be made of the land. Permission may be denied to plant trees or to construct some structures.

Problems arise when spontaneous settlers fail to apply for use rights and when use-right holders attempt to reclaim land that is being used without permission. Conflicts have also arisen between central governments and traditional authorities. These conflicts will have to be resolved at the local level. While land may be vacant, seldom is it not claimed for some purpose. The land may be in fallow, or it may be part of a pastoral cycle utilized on a recurrent basis during part of the year.

Settlers within the AVV settlement blocs do not own the plots they cultivate. Under Burkina Faso law, title to all land within development project areas rests with the state. Settlers do however have a form of use rights similar to that in traditional systems operating in the region.

3.2.5 Village Social Life and Social Continuity

Opportunities for land settlement have created heterogeneous communities for which community organizations must be established and social continuity maintained. Many newly settled communities have evidenced positive signs of community development: a growing ability to regulate their own affairs, the reinstatement of certain rituals and institutions, and the formation of new social and political groups. Community development and social continuity can be enhanced through the creation of development structures that parallel traditional social organizations. These community development groups and the organizations of men, women, and youths sponsored by national political parties create social conditions favorable to community development and social cohesion.

3.2.6 The Role of Women

The opening up of new land for settlement has created opportunities for all members of the community, but these opportunities have not always been extended equally to men and women. This is particularly true in education and agriculture.

Girls still do not represent 50 percent of primary school enrollment, and they represent only a small fraction of secondary school enrollment. Women perform at least half of all agricultural food production activities but receive less agricultural training and less access to credit, animal traction, and other forms of agricultural input than men.

Resettlement involves new household routines and new family division of labor. Women are frequently given heavy new tasks in cash crop cultivation in addition to their domestic responsibilities and those for household food production. Their domestic responsibilities such as food processing, clothes washing, and gathering fuel and water may be made more difficult by reduced access to water and firewood. In many resettlement areas, wells are not yet established, and in some areas wells are located as far as 2-5 km from compounds (Guissou 1977).

In many cases migrant women have lost land use rights to which they were entitled in their home villages. Settlements have not always allowed for women's fields, which has deprived women of traditional sources of income. Women are traditionally responsible for feeding the household's children, and unless women are provided with alternative income-earning opportunities, they cannot easily meet these obligations. The problem is worse in villages where markets have not yet been created, because even the traditional petty trade offers little opportunity. Broader economic participation by women is essential not only to reduce labor constraints but for other reasons as well. Unless women can earn higher incomes both in kind and money, it will be difficult to improve nutritional status levels. Poor nutrition

contributes to the important health problems of the region and to the high infant and child mortality in the area. It is easy to see why the improvement of rural living standards depends to a considerable degree on ensuring that women can make a positive contribution to the development process (WHO, OCP 78.2).

Much more attention must be given to these issues generally, as well as in settlement schemes. Outside interventions, at a minimum, can aim at reducing the demands on women's time through better siting of wells and by providing small mills to reduce the time required for food processing. Because labor is a major constraint in settlement schemes, such policies will have important economic payoffs and also ensure greater equity in the development scheme.

3.2.7 Health and Nutrition

The control of onchocerciasis has undoubtedly had a positive effect on human well-being by removing the nuisance of the blackfly and the threat of blindness and other consequences of the disease. An indirect effect has been the stimulation of construction of health infrastructure by commercial enterprises, government agencies, and nongovernmental agencies in the area. A survey conducted in the Mogtedo region of Burkina Faso revealed that the average distance peasants have to travel to reach a dispensary is far less (7 km) than previously. Midwives and nurses have been trained and they are being supported in some communities, and delivery huts have been constructed by some villages. The 1984 survey of OCP villages found that 70 percent of deliveries were being performed in the village by a traditional birth attendant, only 1 percent of whom had received training (Karam 1985).

By removing a barrier to agricultural use of underutilized land, OCP created opportunities for increased agricultural production (WHO, OCP/GVA 84.1). In the 1984 survey of program areas in Togo and Burkina Faso, 64.3 percent of the villagers said they had achieved a considerable increase in their agricultural production; between 1975 and 1983, 94.4 percent of them estimated the increase to be 31/2 times their original production (Karam 1985).

However, the additional food availability represented by this increased production is not reflected in the anthropometric data. Measurements of 5,947 children in 75 villages within the program area showed that the overall nutritional status of the population was poor. Compared with U.S. National Center for Health Statistics standards, 40 percent of children were below the third centile for weight-for-age and 55 percent of the children were below the third centile for height-for-age. However, only 7 percent, however, were below the third centile for weight-for-height. This distribution implies that chronic undernutrition, rather than brief periods of acute starvation, is the underlying factor in the region. This nutritional inadequacy

is not confined to the onchocerciasis-freed zones, and it demonstrates that improved incomes have not yet improved the diets of the young.

It has been suggested that the reduction in the incidence of blindness may have contributed to an improvement in the level of child survival. This is suggested because the blind individuals were unable to provide adequately for their families and would even represent a burden to other family members. Adequate data have not been collected to test this hypothesis. There is no evidence to suggest that infant mortality is either higher or lower within the program area than elsewhere.

3.2.8 The Natural Environment

The opening up of new lands through the control of onchocerciasis presents opportunities for the enhancement of the natural environment. By reducing the load on overpopulated zones, agricultural land can be returned to full fertility by restoring the fallow period and by controlling erosion through reforestation. The introduction of intensive agriculture based on crop rotation and fertilizer can avoid the soil problems associated with the overpopulated areas.

The 1984 survey of OCP areas in Togo and Burkina Faso indicated that the population there is generally aware of the danger of destroying plant cover and of desert formation (WHO, OCP/GVA 84.1). This awareness has led, in some areas, to reforestation and to a decrease in the use of practices that are devastating to plant cover. However, opportunities for safeguarding the environment are not being taken full advantage of throughout the program area. A survey of spontaneous settlers conducted by the AVV claimed that among the negative effects of spontaneous migrations are (1) deforestation and uncontrolled bush fires resulting in the extermination of animals; (2) overgrazing; and (3) the predominance of extensive cultivation, the lack of efficient cultivation methods, and the cultivation of marginal lands, practices that contribute to the "sahelisation" of the area (Government of Burkina Faso 1985).

While these claims have to be evaluated from a neutral perspective, there is undoubtedly some validity. That is, there will be "mining of the land" in certain cases, particularly when clear title is not accessible to the settlers, and when settlers violate existing land-use rights. The authorities are obliged, therefore, as a priority to resolve ownership rights where settlement is being permitted or encouraged.

3.3 Community Participation in OCP

Until recently there has been little opportunity for community involvement in OCP activities. OCP has carried out an

analysis of all the tasks required for surveillance and control to discern whether and how onchocerciasis control activities could be undertaken by village and village health workers. One of the major difficulties in the involvement of villagers or village health workers is that the control and surveillance of onchocerciasis has required a rigorous, quantitative approach. A second problem relates to the nature of the disease. The long-term course of the disease means that successful control activities do not necessarily produce the sort of immediate results that would encourage villagers to continue. Thus, onchocerciasis might not be the first choice for disease control if villagers were encouraged to undertake health-related activities.

OCP began an information campaign in 1975 to make the population aware of the dangers of onchocerciasis. Posters as well as the media were used to publicize the campaign. The communities were soon able to understand the relationships between the blackfly and blindness, and the objectives of the program. The elimination of the blackfly bites gave people confidence in the usefulness and soundness of the vector control measures.{3}

With greater understanding has come greater villager involvement in OCP activities. The first experiments on these lines are in progress in the Dogon region in Mali. In the Bandiagara area near the Niger River, vector control is carried out from the ground. Several factors make this a good area to initiate efforts in community participation: the seasonal nature of the transmission and geographical limitation of the prevalence

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{3} Note: the information was directed not only to the population at risk, but also to the authorities to win their support and to the donor countries, anxious to keep informed of the progress of the campaign.

of the disease; the presence of a body of motivated volunteers and a dynamic and respected extension agent; and the characteristics of the breeding sites, which are few in number, present primarily during the rainy season, and have low discharge rates so they can be treated economically from the ground. Blackfly control activities are conducted by OCP teams with the support of village health workers who assist with applying the larvicide, collecting larvae, and monitoring the traps; give the alarm when flareups in the biting activity of blackflies are observed; and take hydrological and rainfall readings.

An experiment in entrusting the monitoring of traps (aluminum plate type) to the villagers has been tried in the southwestern part of Burkina Faso. The initial results have been promising. In the proposed western extension, village-based vector collectors will be used when possible.

3.4 Development in the Participating Countries

Although OCP is not directly involved in economic development activities, the final objective of the program is "to reduce the impact of the disease to a level where it no longer represents ... an obstacle to socioeconomic development." Much development investment activity has been undertaken within the program area since the commencement of OCP operations, although a causal relationship cannot always be demonstrated. The following sections present a brief review of the development activity that has occurred in the onchocerciasis-controlled area.

3.4.1 Burkina Faso

Burkina Faso is the first of the participating countries to benefit from liberation from onchocerciasis. It is also the country most in need of new lands (because of population pressure in non-onchocerciasis areas). Burkina Faso also has been perhaps the most activist in planning and implementing actions to exploit the opportunities afforded by OCP.

Burkina Faso created the AVV to excecute development (resettlement, organization, infrastructure) in selected sections of the onchocerciasis-freed zone. Through 1984, the AVV had settled 27,000 people (3,400 families) in supervised settlement schemes that had brought some 12,000 hectares into cultivation. The AVV claims that its zone yields a surplus in food as well as 6 percent of the national cotton production. The aggregate official cost of this AVV program was CFAF20.9 billion (equivalent to about $50 million at the 1985 exchange rates). Although admitting the AVV-sponsored settlement is quite costly in terms of families settled, the organization suggests an intermediate solution for exploitation of other areas in order to preclude the destruction of resources that has accompanied unorganized migration.

Other sections of the onchocerciasis-freed area appear also to have prospered. Spontaneous development as well as that assisted by other official authorities (the Regional Development Organizations [ORD]) according to some estimates has probably exceeded that in the AVV zones. Although comprehensive data for 1974-1984 were not available, the OCP-sponsored census revealed that in the ORD des Hautes-Bassins the area cultivated in corn and cotton increased some 40,000 hectares (42 percent) between 1974 and 1984 (Government of Burkina Faso 1985).

3.4.2 Mali

Although the south and southwest regions of Mali have traditionally been relatively lightly populated (as a result of historical, cultural, and health reasons, including onchocerciasis), the informed consensus seems to be that these areas of the country were not particularly hostage to

onchocerciasis (Government of Mali 1984). Onchocerciasis, for Mali, was only one of its problems. However, the control and promise of control (in the expansion zone) are coinciding fortuitously with a growing understanding that these regions are a vital available resource, given the succession of droughts to which the higher latitudes are subject.

The onchocerciasis zone contained about 2.7 million inhabitants in 1983 (about one-third the total population). There is substantial migration of the population, with a net emigration of farmers and pastoralists from poorly watered areas of the country. Within the zone, there has been movement back toward the rivers once the onchocerciasis threat has been reduced.

The availability of water is a limitation to development in some sectors. However the onchocerciasis-freed zone produces all the cotton and one-half the cereal of the country, and it has been the target of a number of development initiatives (of which a World Bank cotton project is the most successful). Much of the zone, particularly in the south, is sparsely populated and lacks schools, roads, and services. The Government encourages migration toward the "middle" south (around Bogouni), and some impressive advances have been achieved in this region (the trypano-tolerant ranch at Madina). However, the high promise of the area will not be realized without substantial additional effort.

3.4.3 Ivory Coast

The program zone in the Ivory Coast has four and one-half million inhabitants and comprises 270,000 sq km (which includes savanna and forest), or five-sixths of the area of the country. The country has been actively investing in its "up-country" area during recent years (initiatives that are probably unrelated to the success of the onchocerciasis control program) in cash-crop agriculture, agricultural industries, forest products, and animal husbandry. A great variety of other investments in production (e.g., pisiculture and infrastructure) also have been undertaken. The Government has invested about CFAF35 billion ($80 million) in the onchocerciasis zone over the 1976-1983 period (OCP/JPC October 1983).

3.4.4 Ghana

The program zone in Ghana encompasses 45 percent of the land under cultivation, but it is the most neglected and underdeveloped area of the country. Since 1970, the northern and two upper regions have received 76,000 immigrants but lost 262,000 inhabitants, while urban population in the area and the total population (due to natural growth) have increased. The socioeconomic impact study of the area (Benneh et al. 1985, p. 45) notes that "Although the incidence of the Oncho disease had

already forced many people in the zone to abandon their former villages to resettle in new areas, the study did not discover new settlements which have come into existence as a result of such migration." However, the onchocerciasis-freed valleys were being cultivated.

The onchocerciasis zone has received development project assistance from a variety of donors and has developed several water supply and management (irrigation) projects. The pattern of development in the area has been highly variable. At first, the Government encouraged extensive agriculture and irrigation through liberal land-acquisition policies. However, there was substantial environmental damage (erosion, water-logging) and negative reaction by the traditional inhabitants, which led to a sharp diminution of this form of exploitation. The area requires development of infrastructure (access roads), institutions, (banks, credit) and services.

3.4.5 Benin

The program covers 56,000 sq km, with an average population density of 14 people per square kilometer. This area is the least developed of the country, but since the first development plan, about 20 agricultural projects have been underway (projected at CFAF34 billion, or $78 million). Other investments in roads, water points, and other infrastructure are in varying states of progress, according to the Government report (Government of Benin 1985).

Progress has been uneven. In the province of Atacora, the area under cultivation has increased by less than 1 percent from 1974 to 1984, while in the neighboring province of Borgou the increase was 60 percent because of the success of cotton production using animal traction for cultivation. The Government study indicates that it is not clear that the presence of onchocerciasis led to desertion of the river valleys, so the plan is to induce repopulation by whomever will take the work; the overpopulated south is the obvious source of this workforce. This will not be an easy task without the resolution of a variety of social, cultural, and infrastructural problems. At this point the planners are inclined to encourage indigenous development of the zone, but this strategy will preclude rapid expansion of land use because of labor limitations as a result of emigration from the zone.

3.4.6 Togo

The OCP was extended into Togo in 1977. The program area, which had 750,000 people in 1981, covers 18,000 sq km (30 percent of the country). Although the zone had traditionally been isolated and neglected, its prospects were improved by an all-weather north-south road through the region into Burkina Faso

built in 1976. Nonetheless, the population has increased only an average of 1.4 percent a year over the 1970-1981 period (although by as much as 42 percent in some areas) and has declined in some prefectures. A recent sample survey in the region of Lama-Kara revealed substantial recent population movement resulting in the desertion of some communities, the enlargement of others, and a significant intermingling of cultures (as many as 50 percent nonindigenous) in some villages. The rural population increased by 14 percent over the period 1970-1981.

Again the introduction of cotton culture has helped the expansion of the cultivated surface of the zone. Small irrigation, cotton production, animal traction, and regional development projects are underway in the area, some since 1976. There has been substantial improvement in incomes and quality of life among the agriculturalists, a majority reporting increased incomes since the beginning of OCP but not necessarily exclusively attributable to the program. However, farmers do attribute improved production to the program because of their ability to work more outdoors. The area farmed per family has increased, and people have been able to move from the overcrowded plateau. (OCP, "Evaluation de l'Impact... Togo," June 1985.)

3.4.7 Niger

The OCP zone in Niger probably contains the best soils with the most favorable rainfall conditions in that country. An estimated 700,000 ha are arable outside Park W (which contains 300,000 ha), a wildlife reserve. The population density is quite low, about nine people per square kilometer. The rate of population growth from 1971 to 1982 was 2 percent a year. Although the zone has traditionally been an area of resettlement for people from the north affected by drought, the number of such immigrants has been quite modest and probably offset by the exodus of youth.

The OCP in Niger has encouraged official development actions to assist the indigenous populace and the migrants, but development is constrained by difficult access to water for domestic and agricultural purposes. Nonetheless, numerous "mini-projects" centering on subdistricts and villages have been mounted. These include market gardens, plant protection, animal husbandry, training, irrigation, cooperative development as well as phosphate mining, roads, wells, and schools (Aeeou 1985).

APPENDIX D

IMPACT OF ORGANIZATIONAL STRUCTURE ON PROGRAM SUCCESS

by Ali Khalif Galaydh

1. OVERVIEW

The control of onchocerciasis, a debilitating and blinding vector-borne disease, had been attempted on a piecemeal basis prior to the OCP. It had neither the present regional spread nor the critical long-term international financial support. The piecemeal approach and the concomitant applied research in Kenya, Nigeria, Ghana, Ivory Coast, and what was then Upper Volta during the 1950s and 1960s identified the major components of a viable alternative approach. The effective interruption of onchocerciasis transmission in the vector-host-parasite cycle was to be centered on large-scale vector control measures. The absence of a safe, effective, and inexpensive drug for mass treatment has prevented adoption of a strategy based on chemotherapy. Furthermore, the absence of a reliable adulticide and effective biological agents for vector control has narrowed the available options to merely one, the application of larvicides. The meeting in Tunis in 1968 to plan an onchocerciasis control strategy confirmed the technical merit of the emerging consensus, and the Preparatory Assistance to Governments (PAG) mission in its report of 1973 (OCP 73.1) validated the effectiveness of large-scale aerial application of larvicides for interrupting onchocerciasis transmission.

Long-term support, clarity of goal, unambiguous strategy, and flexible action plans have contributed to the coherent structuring process of OCP and its successful implementation. The blight of those afflicted, especially the blind, and the perception of onchocerciasis as a major obstacle to the exploitation of arable lands, especially in the face of recurring droughts, galvanized international support for combating the disease. The active engagement of the heads of the World Bank, the Food and Agriculture Organization (FAO), the U.N. Development Program (UNDP), and the World Health Organization (WHO) epitomized such support. The availability of a feasible strategy enhanced the prospects for continued long-term support. The technical merit of the strategy was to be validated by active monitoring and control of performance and the associated costs.

In the realm of implementation, the World Health Organization, the designated Executing Agency, gained from its vast project implementation experience, and this had direct relevance for the structuring of the Onchocerciasis Control Program (OCP). To facilitate the extrabudgetary funding position of programs such as the Smallpox Eradication and the Special Program for Training and Research on Tropical Disease (TDR), WHO had created appropriate mechanisms for policy, cost, and quality controls. Expert Advisory and Joint Program Committees acted as the oversight structures and played facilitative rather than restrictive roles. OCP benefited from this innovative structuring. The need for a measure of autonomy was a given during the planning and preparation stages of the program. The aim was to minimize the veto/ clearance points in the decision-making structures. This commitment to the provision of a measure of autonomy differentiated OCP from other WHO-executed projects. From its inception, the program had a clear mandate to

discharge its implementation responsibilities with minimum external interference from either the Executing Agency or the participating countries. The program was to enter into financial commitments such as the signing of contracts and to manage its logistics, transportation, and communications.

The management of its logistics, given the geographical and institutional context, and the relative autonomy in its internal operations, particularly in financial and personnel administration, have proved to be significant assets in the successful execution of the program. The justifiable quest for autonomy was, however, to be complemented by an equally justifiable demand for accountability. Striking a balance between autonomy and active monitoring and evaluation to ensure accountability has been a critical concern from the planning to the implementation stages. The general administrative procedures of the Executing Agency have been used for the internal operations of the program, and its internal management systems were designed and installed with the assistance of the Agency. The adoption of these general procedures and the use of specified management system have made monitoring and evaluation relatively easier than they might otherwise have been. A case in point is that of financial management. Although structured to be autonomous in undertaking internal and external financial commitments, OCP has been constrained by the use of standard budgetary/financial procedures, specified financial and information management systems, and prescribed planning and reporting norms. OCP's standard accounting records (journals, ledgers, balance sheets, and reconciliations), inventory and control systems, and budgetary and action plans facilitated the relating of performance to cost, not only for internal and oversight evaluations but also for independent commissions.

Long-term donor support, goal clarity, consensus on strategy, and coherent structuring (facilitative oversight structures and autonomous internal management) have contributed to the realization of the goal of interrupting onchocerciasis transmission in substantial parts of the original program areas. With the extension to the west and south, the goal of successful interruption in the whole area becomes attainable.

However, a requisite for successful implementation has been the availability of well-trained and motivated staff. A challenging scientific task, long-term commitment, and an international salary scale attracted qualified and competent professional staff from the international market originally but increasingly -- through staff development and training -- from the participating and other African countries. The WHO Brazzaville African Regional Office and its Geneva headquarters have assisted in the recruitment and selection of professionals, but the program has been solely responsible for hiring the general staff. WHO personnel procedures are used for the whole staff as they are considered to be employees of the Executing Agency.

Judged by the scope and complexity of the work, the program appears to be a lean organization in terms of number of

employees. The management of communications and transportation has been a crucial component of the autonomy and effectiveness of OCP. Though efficiently run, the need to staff the radio/ telephones, warehouses, workshops, and depots has increased the number of personnel. On the other hand, the program has judiciously contracted out the aerial operations. Some 75 percent of the posts (including the 5.3 percent in applied research, which is essentially for vector control) and 60 percent of the 1985 budget are for vector control. The high percentage of posts (see Table D-1) and budgetary allocations assigned to vector control is in line with the goal, strategy, and action plans of the program during the control phase. The priorities for the maintenance phase are bound to be of a different order.

Table D-1. Proposed Distribution of Posts, 1985

Unit	Professional Staff	General Staff	Total	Percent
Office of Program Director	12	8	20	2.4
Vector Control	23	550	573	69.5
Epidemiological Evaluation	5	46	51	6.2
Socioeconomic Development	4	1	5	.6
Applied Research	7	37	44	5.3
Chemotherapy Project	1	1	2	.2
Administration and Support	10	120	130	15.8
Total	62	763	825	100

Source: OCP/JPC, "Plan of Action and Budget for 1985," p. 55.

2. DEVOLUTION

Onchocerciasis transmission has been interrupted in the original program area. Effective vector control measures, at a cost of approximately $158 million from 1974-1985, have led to the realization of a primary goal of the program. However, this tangible success is threatened by reinvasion from the west and south and the absence of a clearly drawn strategy and operational plans to prevent resurgence of the disease once the control measures are brought to a successful conclusion. OCP, the participating countries, and the donor community are fully cognizant of these serious problems. The Long-Term Strategy addresses reinvasion adequately and puts forth the rationale for extension to the west and south. Devolution -- the post-vector control management of onchocerciasis transmission in the context of the national health administrations -- is a primary concern. Devolution and extension, coupled with the ongoing activities, are the present and future focus of the program.

Once the various phases of vector control (exploration,

preparation, attack, consolidation, and maintenance) are attended to successfully in the whole area, the organizational and resource requirements to combat potential recrudesence and resurgency are going to be different from the current enormous control and surveillance requirements. The sustainability of the interruption of onchocerciasis transmission calls for long-term collaboration and cooperation among the main parties of the program. The integration of onchocerciasis control maintenance into the primary health care systems of the particiating countries requires the restructuring of the vertical program organization and the strengthening of the capability of the national health delivery systems.

More specifically, the sustainability of onchocerciasis interruption by the participating countries requires a more focused definition of the maintenance approach and methodologies to be employed, a coherent structuring, and donor support mobilization. Epidemiological evaluation (particularly the detection of new onchocerciasis cases) and control when and where needed are to be carried out in the absence of OCP entomological survelliance. Although these activities will be on a much more reduced scale than the current efforts, some core onchocerciasis activities will remain, and these need to be identified with certain precision. It is the responsibility for these residual onchocerciasis activities that will be devolved, and the countries will have to cope with them given their resources and already overwhelming health demands. The local health care centers will have to shoulder the added onchocerciasis responsibilities, and central specialized bodies will have to support and attend to management of onchocerciasis-control maintenance.

2.1 The Role of the OCP

The overall success of the program and its proven management competence have given it both credibility and legitimacy to work actively toward facilitating devolution. OCP leads the ongoing spirited discussion on devolution among the National Onchocerciasis Committees and within the meetings of the Expert Advisory Committee and the Joint Program Committee. It has prepared a number of discussion papers that delineate the phasing of devolution, outline a strategy for onchocerciasis-control maintenance within a primary health care framework, emphasize the importance of establishing an intercountry facility, and highlight the need for continued donor support.

OCP has more pointedly facilitated devolution in the areas of training and research and development. From its inception, OCP had a training program for the benefit of its own staff and for enhancing the skills and managerial pool of the participating countries. For the 1974-1984 period, the program trained or retrained 169 professionals and technicians. Of these, 154 are from the participating countries (including 11 professionals). Retraining and reorientation are imperative for most of those who

were trained according to the priorities of vector control. The program is aware of this and has formulated a long-term training policy that emphasizes the relevance and appropriateness (in terms of trainees, subject matter, and training institution) of training. Field and middle-level staff are to be given priority because these personnel are crucial for the promotion of primary health care.

Research and development activities have contributed to the effectiveness of the program, especially with respect to the refinement of its strategies (larvicide development and chemotherapy) and the efficiency of its operational decision-making. The following research areas that will be emphasized to facilitate devolution were identified by the Expert Advisory Committee at its June 1985 meeting (OCP/EAC 6.1):

-- Development of an immunodiagnostic technique

-- Validation and standardization of epidemiological technology

-- Development of fly trapping techniques for community participation

-- Vector/parasite identification and dynamics

-- Operational research on drug delivery when one becomes available

-- Manual control measures

OCP's research and development activities, training, and efforts to crystallize the current thinking on devolution are communicated formally and informally to the National Onchocerciasis Committees, Committee of Sponsoring Agencies, Expert Advisory Committee, and the Joint Program Committee. The program is also a communication channel for the plans, proposals, and feedback from the various committees.

2.2 Participating Countries

The participating countries are convinced of the positive impact of the OCP and the necessity of sustaining the interruption of disease transmission. They are also convinced of the need for an intercountry facility for coordinated surveillance and action. Donor support is also crucial for the successful integration of onchocerciasis maintenance into the primary health care objectives and operations of participating countries. Ultimately, however, the prime responsibility of devolution lies with the participating countries and they realize this. The issue is how to translate that awareness into an integrated, realistic strategy and programmatic action plans. The state of preparedness among the countries varies according to the following factors:

-- Control phase achieved

-- Resource base

-- Infrastructure and institutional capability

-- Political will

-- Donor support

Burkina Faso was the epicenter of onchocerciasis and has, therefore, been the longest exposed to the intensive and extensive operations of the OCP. It was slated to be the first to embrace devolution. Burkina Faso has measured up to the expectations and formulated a plan for devolution. The plan is based on the effective absorption of onchocerciasis maintenance activities (116 indicator villages covered by OCP) by its relatively advanced national primary health care system. The plan presents the staffing requirements and a tentative budget. It elaborates the areas of collaborative work with OCP and designates desired areas for donor support. The political will is abundantly clear, and the technical design work provides an experiment to be assisted and closely studied. Burkina Faso, and the other countries, will benefit from the training, research and development, and other collaborative studies of OCP. Strengthening the primary health care system, a vehicle for multidisease control among other national health goals, is a target area for bilateral and multilateral support. The marshaling of donor support, the support for the development of an intercountry facility, and above all the drawing up of strategies, plans, and programs and their execution are the responsibilities of the participating countries. The realization of the need is not lacking, but the orchestration and the drive are not sufficiently present.

2.3 The Donors

The donor agencies and countries are impressed by the concrete achievements of the program and its overall positive impact. The program has been a donor program in terms of funding (almost 99 percent of the total funding) and oversight structuring. (See Table D-2 for a breakdown of funding by donor through Phase II.) The reports of the donor-established commissions, evaluation committees, and external auditors note the organizational tightness, technical and managerial competence, and productive cost-effectiveness measures of OCP. However, the donors realize only too well that OCP is a vertically organized program with a single disease control approach and a long-term strategy. The donors are keenly aware of the importance of devolution not only because of the post-OCP onchocerciasis maintenance demands, but also because of the deliberate policy position of establishing a time frame for the phasing out of their substantial support. Strengthening national health

planning, in particular primary health care, and encouraging the development of an intercountry facility are the two main pillars of an emerging donor strategy for a gradual and effective devolution.

The initial steps of a donor-assisted devolution are manifested by the mandated support of the African Regional Office of WHO to the Burkina Faso Government. A subregional office is to be opened in Ouagadougou for the specific purpose of spearheading the requisite collaborative work among the participating country, OCP, and the donor community. This collaborative work is to spell out the goals, approaches, and appropriate structures for primary health care. Manpower planning, training, and other management-enhancement interventions are the primary target areas. The mode of donor support (e.g., bilateral, multilateral, a consortium formula) is far from being agreed on. The orchestration and structuring of donor support is a major achievement of OCP. A similar concerted effort, although in a more intractable terrain, is necessary for the devolution process.

Table D-2. Onchocerciasis Fund
March 1, 1974 to December 31, 1985

Contributions/Disbursements	Phase I 3/1/74-12/31/79	Phase II 1/1/80-12/31/85	Total	Percent
Contributions				
African Development Bank	1,085,715	1,436,544	2,522,259	1.51
Belgium	1,735,568	3,542,945	5,278,513	3.15
Canada	3,306,813	5,785,221	9,092,034	5.43
France	5,780,473	4,607,819	10,388,292	6.20
Germany, F.R.	5,237,507	5,274,161	10,511,668	6.27
Iraq	50,000	-	50,000	0.03
Italy	-	2,000,000	2,000,000	1.19
Ivory Coast	1,002,967	1,398,235	2,401,202	1.43
Japan	5,000,000	8,533,200	13,533,200	8.08
Kuwait	6,000,000	5,000,000	11,000,000	6.56
Netherlands	6,500,000	11,256,988	17,756,988	10.60
Norway	1,056,840	2,646,006	3,702,846	2.21
OPEC Special Fund	-	2,000,000	2,000,000	1.19
Sabah Al-Salem Foundation	100,000	100,000	200,000	0.12
Saudi Arabia	1,666,666	11,333,333	12,999,999	7.76
Switzerland	-	7,794,372	7,794,372	4.65
United Kingdom	5,546,372	3,950,360	9,496,732	5.67
UNDP	465,000	2,900,000	3,365,000	2.01
United States	7,700,000	15,282,000	22,982,000	13.71
World Health Organization	-	2,000,000	2,000,000	1.19
World Bank	6,000,000	12,500,000	18,500,000	11.04
Total Contributions	58,233,921	109,341,184	167,575,105	100.00

Disbursements{a}	56,200,000	102,000,000	158,200,000

{a} Excess of receipts over disbursements are applied to the next phase of the program.

Source: World Bank data.

2.4 The Third Phase (1986-1991)

The Third Financial Phase for the extension areas provides an opportunity for OCP to experiment with the demands of devolution. The preparation, attack, and consolidation phases of the extension areas will coincide with the residual control/surveillance and maintenance phase of the original program areas. The technical and managerial experience obtained in the control areas is bearing fruit in the modeling of appropriate strategies and operations. The Third Financial Phase itself is a reflection of the program's impact on the organizational development of OCP. The scope of the analysis (alternative approaches, structure, costing) is a significant improvement compared with the first two phases (see OCP 5.17.1985).

Efficiency-oriented control operations will be carried out in the extension areas, but the infrastructure, logistics, impressive communications network, and motivated staff of OCP will still be in place for the central areas, although operations will be at a reduced rate of intensity. The applied research-based perspective and methodical pragmatic orientation of the program will be an asset in the devolution process. Burkina Faso is the pilot scheme for identifying the major components of investigation: goals, strategy, operational funding, and the scope of required cooperation and consulation. Techniques and technologies of surveillance, diagnosis, control, and other remedial actions are to be tested for their simplicity, cost-effectiveness, and efficiency in the context of primary health care. Realistic manpower planning coupled with relevant and appropriate training, institutional development-enhancing interventions, community participation, and the effective interfacing of participating governments, the intercountry facility, and donors are some of the factors that impinge upon the devolution process. OCP, the participating countries, and the donors have the time, resources, and willingness to attend to the competing demands of devolution. The Third Financial Phase affords them the opportunity to experiment and to devise technically feasible strategies and financially viable operations for devolution.

2.5 Extension Areas

The objectives of extending the program operations to the

western and southern areas are to combat reinvasion and to interrupt the transmission of onchocerciasis in these areas. The experience gained in the original program area facilitates the efficiency of control and evaluation operations in the extension areas. The proposed structuring in the extension areas also provides yet another experiment for devolution. The national staff, within the context and perspective of primary health care, will be responsible for the entomological and epidemiological evaluations. OCP has trained or retrained some 24 professionals and technicians from the extension areas and has joint responsibility with the national governments for selecting the right individuals. OCP will give them supplements (primes) in addition to the salaries provided by their respective governments. This is a cost-effective measure, and the whole arrangement of working within the national structures is a relevant and significant experiment for devolution.

OCP will be responsible for the systematic destruction of the vector in these extension areas. It will also supervise (quality and cost) the evaluation work of the national organizations. This is devolution from the outset: a multipurpose approach in contrast to the single-purpose approach of OCP in the original areas. The differential capacities and responses of the national organizations are to be studied in order to specify the areas of weakness in their health delivery systems and to focus attention on the extent of necessary improvements. The evolving role of the intercountry facility would be better grasped and donor support could be better structured. In summary, flexible planning, monitoring, and evaluation of devolution could be carried out in the extension areas. This, coupled with the devolution process in the central areas, will move the current concern with devolution to a more focused strategy formulation and implementation.

3. OCP AS A MODEL

OCP as a multidonor, multination, long-term, single-disease control approach has achieved its stated objectives. There is apparent consensus on the goal, strategy, and operational plans of the program among the donors, participating countries, and OCP management. Interruption of onchocerciasis transmission is a major goal of the program. Vector control is the unambiguous strategy, and application of larvicides through aerial operations is the core of the operating plans. This apparent consensus facilitated the successful implementation of the strategy of this vertically organized program. As a model, OCP has direct relevance for other vertical programs. As a component of an integrated development strategy, it also has some significant relevance. Obviously, however, it cannot be considered as a single tool for achieving development objectives.

3.1 The Structure

The OCP structural configuration has met the requirements of the participating countries, sponsoring agencies, and donors. Its internal structure has contributed significantly to the successful implementation of the OCP strategy. The main components of the managerial structure are as follows:

-- The Joint Program Committee is the policymaking organ and has representatives from the participating countries, donor agencies, and the four sponsoring agencies. The committee supervises the program and the Executing Agency (WHO) and meets once a year.

-- National Onchocerciasis Committees have been formed in each of the participating countries to ensure liaison with the program and to coordinate national onchocerciasis-related activities, particularly in the onchocerciasis-freed zones.

-- The Expert Advisory Committee comprises 12 renowned experts in fields directly related to onchocerciasis. They are appointed by WHO for 2-year periods, meet twice a year, and make frequent site visits. The Committee reviews the scientific and technical operations of the program and reports findings to WHO. The Ecological Group, although invested with independent status, is a subgroup of the Committee.

-- The Committee of Sponsoring Agencies comprises representatives of WHO, UNDP, FAO, and the World Bank. The Committee coordinates and guides the activities of the agencies, reviews the plans and programs of OCP, and supervises overall implementation. The Committee also acts as the Secretariat for the program.

-- The World Health Organization is the Executing Agency of the program. The Agency, in consultation with the Committee of Sponsoring Agencies and the participating countries, appoints the Program Director. It provides technical and administrative assistance to the program and is responsible for implementing approved action plans and strategies.

-- The World Bank manages the Onchocerciasis Trust Fund. Funds are disbursed quarterly through the Executing Agency. The Bank mobilizes the necessary financial support from the community of donors and contributes from its own resources. The Bank's management of the Trust Fund and membership in the Committee of Sponsoring Agencies confers an aura of confidence to the operations of the OCP.

The oversight structure of OCP has remained unchanged since the inception of the program, with the exception of the

streamlining and modification of the roles of the original advisory panels. The Economic Development Advisory Panel, the Scientific Advisory Panel, and the Technical Advisory Panels were replaced by the Expert Advisory Committee. The scientific and technical functions were fused with relative ease, but the subsuming of the economic development functions under the Expert Advisory Committee has relegated them to a marginal role. Moreover FAO, as an Associate Agency, and the UNDP, in line with this relegation of economic advisory functions to a marginal role, have shied away from active monitoring and promoting of socioeconomic development in the onchocerciasis-freed zones. The participating countries were to seek the support of FAO, UNDP, and the World Bank to actualize some of the development potential of the freed zones. The structuring of such support, even at the advisory level, has not been successful. The socioeconomic development unit of OCP has, therefore, been a poor relative of the other units.

OCP is one of a few select WHO programs which, because of extrabudgetary funding to reach clearly focused goals, have developed special structures for evaluation and quality control (Expert Advisory Committee) and policy and cost control (Joint Program Committee). Partly because of its geographical location, OCP has a measure of autonomy that is unique among WHO-executed projects and programs. OCP enjoys the special attention and support of the WHO Director-General. (Although OCP comes under the WHO African Regional Office in Brazzaville, that office apparently excercises very little authority over the program.) The management of the Executing Agency is cogizant of the degree of autonomy held by OCP, which enables it to work around WHO structures and national organizations. This relative autonomy has contributed significantly to OCP's success. There is a marked unanimity among participating countries, WHO management, and OCP itself about this.

In administrative matters, OCP follows the general procedures of its Executive Agency. WHO also provides technical and general backstopping assistance. OCP uses WHO's Vector Biology and Control and the Parasitic Disease Programs and the Special Program for Training and Research in Tropical Diseases for screening potential insecticides and drugs for chemotherapy. Aerial operations contracts, bulk purchases of equipment and materials, staff selections, and computerized data analyses are the major areas in which WHO extends assistances. WHO also helps maintain diplomatic and duty-free status in the participating countries for program staff and materials supply.

The chief executive officer of OCP is the Program Director, who has overall responsibility for all operations. There are four technical units: vector control, epidemiological evaluation, socioeconomic development, and administration and support services. The 1985 budget provides for 62 professional staff and 763 general staff. Geographically, OCP has 7 sectors and 22 subsectors. These are connected to the Ouagadougou headquarters by a radio-telephone network. This network links the OCP aircraft for larvicide treatment with the two airbases in what is an extremely functional, responsive arrangement. The

communications system and the efficient logistics system (a fleet of 250 surface vehicles as well as central and regional workshops) provide the program with the necessary infrastructure for its demanding operational tasks. Although the program is centralized in structure and operations, the need for swift response for larvicide treatment has necessitated some delegation of responsibility to the sector and subsector chiefs. Supervision of these delegated responsibilities is facilitated by precise norms for surveillance, evaluation, and treatment and the excellent communications.

The internal management of the program (planning, programming, and budgeting and performance and reward) were installed with the assistance of WHO. These systems have been upgraded over the years as a result of ongoing applied research and use of better analytical and management tools. An intangible but potent plus for the OCP organization is the high motivation of its employees. A challenging scientific task, a carefully constructed career ladder, and an international salary scale provide the necessary incentives. Pesticide resistance, fly reinvasion, and certain ambiguities in policy direction damaged staff morale in the late 1970s and early 1980s. But scientific breakthrough and inspired leadership succeeded in reestablishing morale by 1983. Being associated with an efficiently executed and successful operation reinforces commitment and esprit de corps.

The oversight functions of the various committees, although effectively handled in general, appear to be somewhat hampered by overly complex agendas and open-ended meetings. Roughly 1.5 to 2 percent of the annual budgets of the program are expended on statutory meetings of various committees and scientific working groups (OCP/JPC 5.5). The advisory and support role of the associated agencies (FAO and UNDP) seems less than robust and monitoring of the socioeconomic impact of the program has not been actively pursued. The socioeconomic development unit reflects this deficiency. Its technical inputs in the promotion, planning, and execution of development projects in the onchocerciasis-freed zones are marginal. Remedial measures by the participating countries, donor community, and OCP are needed for the active monitoring and promotion of socioeconomic development in the freed areas. The Expert Advisory Committee's responsibility is to review the scientific and technical operations of the program. But because the members are appointed by the Executing Agency (WHO), the relationship could become problematic, even though the members are internationally renowned and their integrity is beyond reproach. The role of the Committee could also be adapted to be more evaluative than reviewing. Despite these limitations, the results of the program indicate strongly that the oversight mechanisms have worked effectively and that the internal management systems have proved to be reliable and efficient.

3.2 Cost-Effectiveness of OCP Operations

A simple assessment of the cost-effectiveness of OCP strategy and operational plans is difficult to achieve because of several complicating factors: (1) the absence of safe, effective chemotherapy methods for mass application against onchocerciasis; (2) the absence of alternative, effective vector control agents; (3) the capability of the adult blackflies to migrate long distances; (4) the larval susceptibility to control; (5) the inaccessibility of most of the breeding sites, especially during the rainy seasons; and (6) the inadequacy of manual treatment and control for large areas.

Aerial vector control using larvicides is the only available strategy for widespread use. Moreover, a cost estimation demonstrated that aerial applications cost only half as much as conventional surface control (which later proved ineffective in reducing transmission) (WHO, VBC 81.2, p. 59). In the absence of appropriate cost-effectiveness criteria (alternative approaches and their impact), the program has taken a cost-minimization orientation. Ongoing monitoring and evaluation are undertaken for operational efficiency and effectiveness. An institutionalized system of applied research is in place for optimizing operational costs. Different flight configurations (fixed-wing and helicopters), schedules of treatment, type of larvicide and dose, surveillance and evaluation techniques (Bellac trap), and types of equipment (teletransmission and diesel vehicles) are tested for efficiency and cost advantage. The program has benefited enormously from its applied research operations in the context of tight budgets and often expanding operational activities.

Several factors facilitate the monitoring of cost-minimization efforts:

-- Apparent consensus on the goal, strategy, and operational plan

-- An oversight structure with multiple review committees

-- Use of open and competitive bidding, through WHO's procurement system, for major contracts (aerial operations) and procurement of equipment, materials, and supplies

-- The quantity and quality of the data generated for the thorough review and evaluation of budgets and financial plans

-- The management of the Trust Fund by the World Bank

-- The internal and external auditing instruments

Minor losses of insecticides and fuel were mentioned in the External Auditor's Report of 1984. No complaints have been registered by the private sector in donor countries concerning the awarding of contracts or the procurement of equipment, materials, and supplies. The computerized supplies management

system prevents excessive stockpiling of larvicides, and even if such stockpiling were attempted, the approximate seasonal requirements are well known by the auditors, Executing Agency, and Trust Fund management. The sound standardization and depreciation policies, good inventory management, and strict expenditure controls (a Sector Chief has an expending authority ceiling of $12) are examples of the cost-minimization effort. The wealth of accounting and financial data provided in the monthly return, quarterly, and annual statements and frequent review reports makes the tasks of external monitoring and evaluation manageable.

Cost minimization has to be understood in the context of the apparent consensus on the goal, strategy, and operational plans. Aerial application is the most reliable and cost-effective means of covering all breeding sites in all seasons, especially during the control phases (preparation, attack, and consolidation). During the maintenance phase, some inaccessible areas will still require aerial applications, although surface techniques should be adequate in some (possibly substantial) areas. Bandiagara, Mali, although unique in its combination of appropriate physical setting, security from reinvasion, social structure, and energetic OCP leadership, provides a striking example of the feasibility of local monitoring and treatment during the maintenance phase. This example has valuable implications for devolution. That is, local, manual application of larvicide during some or all seasons in conjunction with aerial treatment when necessary may be possible. The appropriate techniques for community-based surface maintenance need to be worked out and tested.

3.3 OCP as an Agent for Improving Health Systems

OCP as a long-term, multination, single-disease control program is unique in its operations and structure. It operates in participating countries whose health services are not given a high priority in the national budget and development plans. Strengthening these health systems will require time and enormous resources and is bound to be extremely complex. In contrast, the OCP has introduced a "can do" spirit and attitude, particularly among the disadvantaged rural populace. The regional cooperative aspect of the program has engendered support for a future intercountry facility for surveillance, evaluation, and control of other diseases as well as onchocerciasis. Thus, the success of OCP has led to growing support for OCP-type health services for an attack on other types of health problems as well.

Training is an area in which OCP has had a strong impact. With the implementation of the current long-term strategy, the impact on participating country health care systems is likely to be even more significant. Initially, the objective of the training program was to develop OCP's own staff, but the importance of training national health employees in onchocerciasis-related fields was not lost on the management of

the program. The results in the First Phase (1974-1979) were, however, not impressive. The WHO Independent Commission said as much in its 1981 report and recommended establishment of a special unit for designing and executing a training strategy. The types, levels, subject areas, and location of training were to be spelled out clearly. Although a special unit with a clear mandate was never created, a realistic strategy based on extensive discussion with the National Onchocerciasis Committees has evolved and is now being pursued.

The candidates for the various training programs are employees of country health administrations who have the requisite qualifications and are assured of employment by their governments once they have completed their training. To minimize the potential for misuse, OCP will be involved in the selection process. The strategy envisages three levels of training (OCP/NOC June 1985):

1. Level I is for university graduates seeking a specialization (1-3 years).

2. Level II is for specialists seeking additional specialized training within the OCP area context (3-12 months).

3. Level III is for medical officers and technicians interested in learning about the program methodology (4-6 months).

In addition to this conventional training, the program includes shorter term refresher, orientation, and on-the-job training. By the middle of 1984, OCP had trained or retrained 169 employees (see Table D-3): 64 for itself, 66 for the participating countries, 24 for the OCP extension areas, and 15 for other African countries.

Training has focused on subjects related to the OCP objective of eliminating onchocerciasis as a threat to public health and as a barrier to socioeconomic development. As of July 1985, 48.4 percent of the total number of trainees were in entomology, 18.6 percent in parasitology-epidemiology, 15.3 percent in hydrobiology, 7.9 percent in ophthalmology, 5.1 percent in health economics, 1.9 percent in languages, and 2.8 percent in administra-tive sciences (see Table D-4). The shorter duration programs, such as refresher courses, orientation, and workshops, constitute 42 percent of all training; most of these courses use in-house facilities. OCP has used the training institutions in West Africa (OCCGE and ORSTOM centers, national institutes, and universities) for 43.8 percent of its training program. Familiarization courses and the bulk of the subprofessional-level training were carried out in these regional facilities. The majority of the specialized training (14.2 percent of the training program), however, was done overseas because regional resources were not adequate for that type of training. Currently, although some of the specialization is still being offered overseas, the regional facilities are being used

increasingly.

The training policy has provided successful staff development for the program. Fifty percent of the professional staff are from the participating countries, and, of these, 50 percent have been trained or retrained by the program. (Below the Sector Chief level, all OCP staff are nationals.) OCP has also trained or retrained the employees of the participating countries who are involved in onchocerciasis-related work. A nucleus of specialists and middle-level employees trained by OCP is also being used to staff the country health services.

If the manpower needs were confined to those required to interrupt the transmission of onchocerciasis, the training strategy would be right on target for both the present program area and the extension area. However, with the maintenance phase of the program comes a need for retraining to cope with the different requirements of this phase and the need for training in broad-gauged skills for combating communicable endemic and epidemic diseases. The type, level, subject area, and number of

Table D-3. OCP Training to July 31, 1984, by Country of Trainee and by Discipline

Country	Ento-mology	Para-sitology/ Epidemi.	Ophthal-mology	Hydro-biology	Health Eco.	Admin. Lang.	Sciences	Total	%
Benin	8	1	1	5	1			16	9.5
Ivory Coast	8			2	1			11	6.5
Ghana	9	4	1	4	3	1	1	23	13.6
Burk. Faso	10	12	1	2	1	1	3	30	17.8
Mali	13	6	1	4	1			25	14.8
Niger	5		1					6	3.6
Togo	16		1	2				19	11.2
Guinea	7	3	2	3				15	8.9
Guinea Biss.	2							2	1.2
Senegal	2				1			3	1.8
Sierra Leone	1	3						4	2.4
Other Countries	8	3			2	2		15	8.9
Total	89	32	8	22	8	4	6	169	100

Source: OCP, "Nombre de Beneficiares d'une Formation Assurv,e par OCP par Pays et par Discipline (Arret, au 31 Juillet 1984)," p. 1.

Table D-4. Training, by Discipline, as of July 1985

	1974-	1985

Discipline	July 1984	(to July)	Total	Percent
Entomology	89	15	104	48.4
Parasitology/Epidemiology	32	8	40	18.6
Ophthalmology	8	9	17	7.9
Hydrobiology	22	11	33	15.3
Health Economics	8	3	11	5.1
Languages	4	-	4	1.9
Administration	6	-	6	2.8
Total	169	46	215	100

trainees have to be adjusted to the requirements of the emerging primary health care priorities. The training strategy of the program is addressing this challenge.

The articulated priority is the training of middle-level and lower-level employees. OCP and regional training facilities will be relied on even more than before. The subject areas will have to incorporate other diseases and public health issues. The onchocerciasis maintenance phase and the integration of onchocerciasis-control activities into the primary health care systems of participating countries pose an enormous task for OCP and the participating countries. The technical skills component of the training of the necessary personnel is not beyond reach. The difficulties lie in the restructuring of the country health services, which have to be made more rural- and community-development oriented. Administrative reforms and the mobilization of community resources for community needs are, needless to say, country responsibilities, and OCP can only provide limited assistance. Close cooperation among the participating countries and OCP is obviously of utmost importance in the review, adaptation, and execution of this training strategy.

4. CONCLUSIONS

1. The oversight mechanisms and internal structure of the program have been very effective and have contributed significantly to the goal of interrupting onchocerciasis transmission.

2. The socioeconomic advisory functions of the associated agencies (FAO and UNDP) and the World Bank have not been successfully carried out. The socioeconomic development unit of OCP has not taken the active role envisioned for it in monitoring the impact of the program or promoting development projects in the onchocerciasis-freed zones.

3. The Expert Advisory Committee's responsibility is to review the scientific and technical operations (quality control) of the program. But because its members are appointed by the OCP Executing Agency (WHO), the relationship could become

problematic, even through the members are internationally renowned and their integrity is beyond reproach. The role of the Committee could also be adapted to be more evaluative than reviewing.

4. The apparent consensus on the goal, strategy, and action plans of the program led to an evaluation focus that emphasizes cost-minimization rather than cost-effectiveness. More tests on manual treatment operations, such as those being used in Bandiagara, need to be carried out because this could be a useful approach during the community-based maintenance phase.

5. The training strategy of the OCP has been successful in meeting the localization and staff development goals of the participating countries. The manpower needs for devolution within the context of the primary health care systems of participating countries pose a serious challenge for training. The priority of the current strategy is the training of middle- and lower-level employees in OCP and regional training institutions.

APPENDIX E

METHODOLOGY

The Onchocerciasis Control Program (OCP) is multilaterally funded and implemented by an official international agency -- the World Health Organization (WHO). Although the United States has been the single largest donor, its contribution to the program has been but a fraction of the total (approximately 12 percent). The OCP was designed as a single-purpose program, which would be unencumbered by individual donor idiosyncracies. It is an object of interest for AID as a possible model for other assistance initiatives even though, as a multilateral activity, it is not as accessible to AID review and assessment as are AID's regular bilateral programs.

In undertaking this impact review, AID had to be sensitive to the concerns of other donors and careful to minimize the inevitable disruption of OCP operations. The six review team members were briefed individually before convening in Washington, D.C. for a 3-day workshop to draft a work plan. The draft plan which emerged in Washington prevailed, for the most part, throughout the field exercise. While in Washington, D.C. the team was also able to meet the OCP Director, Dr. Samba, the OCP-WHO liaison officer, Douglas Marr, and the World Bank OCP project officer, Jean Paul Dailly.

The team convened in Ouagadougou Tuesday evening, July 23 shortly after arrival in Burkina Faso. The team members agreed to (1) meet collectively or individually with OCP staff and other relevant sources in the city, including WHO, the Government of Burkina Faso, the U.N. Development Program (UNDP), and AID; (2) pursue individual research as time allowed; and (3) convene as a

team each evening to discuss progress and problems and to revise the assessment outline. This approach worked very well. OCP provided a full-scale briefing by its senior staff and welcomed intensive interviewing and examination of documents throughout the team's stay in Ouagadougou.{1} At the end of the first week the team had studied much of the available documentation and had refined and affirmed the assessment outline.

The second week was devoted to visiting OCP operations in the field, interviewing field staff, and being briefed by technical personnel of related organizations and the participating governments. The team spent 2 working days in Bobo-Dialassou, Burkina Faso, the headquarters of the western operational zone, observing a full day of headquarters operations. Team members also contacted ORSTOM for its views on onchocerciasis control, witnessed an aerial larviciding operation, visited an onchocerciasis-free village, an irrigated rice perimeter, and the Banfora sugar plantation in the onchocerciasis-freed zone.

To focus on their respective specialities, the team separated into smaller groups for the latter part of the week. Among the sites visited were "oncho cells" in Ghana, Ivory Coast, and Mali, the rice plantation and mill in Bouake, Ivory Coast, the Government hospital for onchocerciasis-chemotherapy at Tamale, Ghana, the subsector OCP headquarters at Sikasso and Bamako, Mali, the tea plantation and trypano-resistant cattle ranch in onchocerciasis-freed southern Mali, and the planning headquarters for the OCP western extension zone in Bamako. The team reassembled in Ouagadougou on the weekend of August 3-4 to exchange experiences, documents, and insights. August 5 and 6 were spent preparing first draft contributions to the main section of the assessment report. The balance of the week was devoted to supplementary research, final interviews with OCP Headquarters staff, and the drafting of the technical appendixes. During the hourly evening sessions, drafts were reviewed and adjusted as needed. The team agreed that rough drafts of the main section of the report and the technical appendixes would be passed informally to OCP Director Samba prior to departure from Ouagadougou. Consequently, drafting, typing, and compiling had to be extended 2 days. A draft copy was presented to OCP on Monday, August 12.

The team's itinerary on their return to the United States included stops in Niamey, Niger, Cotonou, Benin, and Lome, Togo in order to consult with technical advisers and to confirm tentative conclusions. In addition, discussions were held with FAO in Rome, WHO in Geneva, and UNDP in New York City, enroute to Washington, D.C.

The team then dispersed to prepare the final report draft. The team leader organized the first complete draft, while the other members proceeded with revision of the technical appendixes.

{1} Arranging transportation logistics and visas for the seven-country itinerary was time-consuming and frustrating. The

OCP headquarters and the Embassy provided some assistance, but much additional effort had to be expended by the team itself. On the basis of this experience the team recommends that a full-time administrative aide be locally contracted to manage logistics affairs for assessment teams in the future.

BIBLIOGRAPHY

Aeeou, Y.S. "Etude Socio-Economique dans la Zone du Programme de Lutte Contre l'Onchocercose au Niger." Ouagadougou: OCP, May 1985.

Awadzi, K., M.A. Aziz, K.Y. Dadzie, H.M. Gilles, D.R.W. Haddock, and H. Shulz-Key. "The Chemotherapy of Onchocerciasis." Annals of Tropical Medicine and Parasitology 79, no.1 (1985):63-78.

Barnley, G. "Control of Simulium Vectors of Onchocerciasis in Uganda." Proc. 10th Int. Cong. Ent. 3 (1956):535-537.

Benneh, G., L.O. Gyekye, E. Amamoo-Otchere, and J.K. Fosu. "Socio-Economic Impact Study of the Onchocerciasis Freed Zone in Ghana." (A report to the Onchocerciasis Control Programme by the National Onchocerciasis Secretariate). June 1985.

Dadzie, Y., A. Rolland, and B. Thylefors. "L'Evaluation Ophthalmologique du Programme de Lutte Contre l'Onchocercose dans la R,gion du Bassin de la Volta: Resultats Apres 7 a 8 Ans d'Op,rations de Lutte Insecticides." (R,dig, pour la Commission de Strat,gie … Long Terme.) Rap. Int. OCP, 1984.

Dadzie, Y., A. Rolland, and B. Thylefors. "The Evolution of Ocular Onchocerciasis in the Volta River Basin Over the Period of Five Years of Vector Control." Annals of Tropical Medicine and Parasitology 35, no.1 (1984):41-46.

Dadzie, Y., A. Rolland, and B. Thylefors. "Occular Onchocerciasis in OCP Areas Under Vector Control." Abst. Int. Cong. Trop. Med. Mal. Calgary, September 1984.

Dailly, J.P. Personal impressions after visit to the Onchocerciasis Control Programme area in December 1984.

Faruqee, Rashid. Analyzing the Impact of Health Services: Project Experience From India, Ghana and Thailand. World Bank Staff Paper No. 546. Washington, D.C., 1982.

Government of Benin. Ministry of Planning and Statistics. "Evaluation de l'Impact Socio-Economic du Programme de Lutte Contre l'Onchocercose au Benin (1974-1984)." (Document Provisoire). May 1985.

Government of Burkina Faso. Ministry of Public Health.

"L'Impact Socio-Economique du Programme de Lutte Contre l'Onchocercose au Burkina Faso (1974-1984)." 1985.

Government of Burkina Faso. Ministry of Public Health. National Onchocerciasis Committee and National Committee on Devolution. "Plan d'Operation de la Devolution au Burkina Faso." June 1980.

Government of Burkina Faso. Ministry of Public Health. National Onchocerciasis Committee. Volta Valley Development Agency. "Burkina Faso: la Patrie ou la Mort, Nous Vaincrons." June 1985.

Government of Mali. Ministry of Planning. "Planification du D,veloppement des Zones Liber,es de l'Onchocercose: Evaluation des Ressources en Terres." Bamako, Mali, 1984.

Guissou, J.N. "Etude sur les Besoins des Femmes dans les Villages de l'AVV et Proposition d'une Programme d'Intervention." Ouagadougou: SAED, April 1977.

Hervouet, J.P. "Bilan de l'Occupation des Terres des Vall,es Liber,es de L'Onchocercose Apres 10 Ans de Lutte Antisimuldienne, Haute Volta." (undated).

Hervouet, J.P., and A. Prost. "Organisation de l'Espace et Epidemiologie de l'Onchocercose." In Matrise de l'Espace Agraire et D'eveloppement en Afrique Tropicale. Memoire ORSTOM No. 89 (1979):179-189.

Hughes, M.H. "Association of Population Changes With Blindness Rates in the Kassena-Nankanni Division of Navrongo District." Doc. Non-Publi'e, Archives Nationales du Ghana, Ref. Health 34, 1949.

Hunter, M.H. "River Blindness in Nangodi, Northern Ghana: An Hypothesis on Cyclical Advance and Retreat." The Geographical Review 56 (1966):398-416.

Karam., M. "Socioeconmic Analysis of the Oncho-Freed Zones." Ouagadougou: OCP, 1985.

Kirkwood, B., and P. Smith. "Mortality, Visual Acuity, Micro Filarial Load and Nutritional Status." (An analysis of epidemiological data for the OCP.) London: London School of Hygiene and Tropical Medicine, Tropical Epidemiological Unit, 1985.

Kouassivi, Benissan. "Rapport sur les Enquˆtes Socio-Economique Men,es dans la Moyenne et Haute-Kara." Ouagadougou: OCP, March 1985.

Lefait, J.F. "Aspect Clinique, Epidemiologique, et Psychosocial de l'Onchocercose en Zone de Savane Africaine dans la Region de Bamako." Doctoral Thesis (medicine), Marseille, 1976.

McMillan, Della. "Changing Patterns of Grain Production in a Resettlement Scheme in Upper Volta: A Report for the Center for Women in Development." Gainesville, Florida: University of Florida and Southeast Consortium for International Development, April 1984.

Onchocerciasis Control Program. "Draft Plan of Operations for the Implementation of the Long-Term Strategy During the Third Financial Phase (1986-1991)." 1985. (OCP 5.17.1985).

Onchocerciasis Control Program. "Evaluation de l'Impact Socio Economique dans la Zone du Programme de Lutte Contre l'Onchocercose: Rapport sur la Situation du Togo." (Provisoire). June 1985.

Onchocerciasis Control Program. "Nombre des Beneficiaires d'une Formation Assurv,e par OCP par Pays et par Discipline (arret, au 31 Juillet 1984)." n.d.

Onchocerciasis Control Program. Note on the Levels of Training. n.d.

Onchocerciasis Control Program. "Onchocerciasis Control Programme in the Volta River Basin Area: Long-Term Strategy, Information Document." (OCP 84.4a).

Onchocerciasis Control Program. "Onchocerciasis Control Programme in the Volta River Basin Area: Progress Report for 1984." (OCP/PR 84). 1984.

Onchocerciasis Control Program. "Onchocerciasis Control in the Volta River Basin Area: Report of the Mission for Preparatory Assistance to the Governments of: Dahomey, Ghana, Ivory Coast, Mali, Niger, Togo, and Upper Volta." 1973. (OCP 73.1).

Onchocerciasis Control Program. "Onchocerciasis Control Programme in the Volta River Basin Area: Proposal for a Long-Term Strategy." 1984. (OCP 84.4).

Onchocerciasis Control Program. "Onchocerciasis Control Programme in West Africa: Plan of Operations for the Implementation of the Long-Term Strategy During the Third Financial Phase (1986-1991)." 1985. (OCP 17.5.85).

Onchocerciasis Control Program. "Towards Devolution: How, When, and With What Means?" 1985. (OCP 5.13.1985).

Onchocerciasis Control Program. "Who Does What in Devolution." n.d.

Onchocerciasis Control Program/Expert Advisory Committee. Sixth Session, Ouagadougou, 10-14 June 1985. "Plan of Operations for the Implementation of the Long-Term Strategy During the Third Financial Phase (1986-1991)." June 1985. (OCP/EAC 6.1).

Onchocerciasis Control Program/Joint Program Committee. "Developpement Socio-Economique des Zones Liber,es de l'Onchocercose en Cote d'Ivoire." October 1983.

Onchocerciasis Control Program/Joint Program Committee. Quatrieme Session, Paris, 12-15 Decembre 1983, Point 9 de l'Ordre du Jour Provisoire. "Ministere de l'Economie et des Finances, Direction des Investissements." 1983. (OCP/JPC 4.4a).

Onchocerciasis Control Program/Joint Program Committee. Fifth Session, Niamey, 3-6 December 1984, Provisional Agenda Item 6. "Onchocerciasis Control Programmme in the Volta River Basin Area: Progress Report of the World Health Organization for 1984 (1 September 1983 to 31 August 1984)." (OCP/JPC 5.2).

Onchocerciasis Control Program/Joint Program Committee. Cinquieme Session, Niamey, 3-6 Decembre 1984, Point 11 de l'Ordre du Jour Provisoire. "Rapport sur le D,veloppement Socio-Economique des Zones Liber,es de l'Onchocercose." 1984. (OCP/JPC 5.4).

Onchocerciasis Control Program/Joint Program Committee. "Plan of Action and Budget for 1985." October 1984. (OCP/JPC 5.5).

Onchocerciasis Control Program/Joint Program Committee. Fifth Session, Niamey, 3-6 December 1984, Provisional Agenda Item 8. "Onchocerciasis Control Program in the Volta River Basin Area: Expert Advisory Committee Report of the Fifth Session, Geneva, 19-22 June 1984." 1984. (OCP/JPC 5.6).

Onchocerciasis Control Program/Joint Program Committee. Fifth Session, Niamey, 3-6 December 1984, Provisional Agenda Item 8. "Onchocerciasis Control Program in the Volta River Basin Area: Expert Advisory Committee Report of the Fifth Session, Geneva, 19-22 June 1984." Annex III: Ecological Group Meeting. 1984. (OCP/JPC 5.6).

Onchocerciasis Control Program/Joint Program Committee. Fifth Session, Niamey, 3-6 December 1984, Provisional Agenda Item 9. "Onchocerciasis Control Program in the Volta River Basin Area: Proposal for a Long Term Strategy." (OCP/JCP 5.7).

Onchocerciasis Control Program/National Onchocerciasis Committee. "Ninth Meeting of the NOC: Training Policy." Yamoussoukro, Ivory Coast, June 1985.

Onchocerciasis Control Program/Working Group on Devolution. "Rapport du Groupe de Travail sur la Devolution, lere Reunion." Ouagadougou, November 1982.

Onchocerciasis Control Program/Working Group on Devolution. Third Meeting. Ouagadougou, 1984.

Onchocerciasis Control Program/Working Group on Devolution. "Rapport de la 4eme Reunion de Group de Travail sur la Devolution." Ouagadougou, April 1985.

ORSTOM. "Project Inter-Pays d'Etude de Faisabilit, d'une Campaigne de Lutte Contre l'Onchocercose dans la Region du Bassin du Fleuve Senegal: Etude Socio-Economique, Rapport de Syntheses." WHO, 1984.

Paris, F. "Etude Geographique d'une Zone d'Endemie Onchocerquienne: Bougouriba, Volta Noire." Doc. ORSTOM. Ouagadougou, 1980.

Pelissier, P. Les Paysans du Senegal. Saint Yrieix, Imprimerie Fabregue, 1966

Philippon, B. "Etude de la Transmission d'Onchocerca volvulus per Simulium damnosum en Afrique Tropicale." Trav. Doc. ORSTOM No. 63, p. 308.

Prost, A., and F. Paris. "L'Incidence de la Cecit, et ses Aspects Epidemiologiques dans une Region Rurale d'Afrique de l'Ouest." Bull. Org. Mond. Sant'e 61 (1983):491-499.

Prost, A., and N. Prescott. "The Cost-Effectiveness of Blindness Prevention by the Onchocerciasis Control Programm in Upper Volta." Bulletin of the World Health Organization 62 (1984):795.

Prost, A., J.P. Hervouet, and B. Thylefors. "Les Niveaux d'Endemicit, dans l'Onchocercose." Bull. Org. Mond. Sante' 57 (1979):655-662.

Roberts, J.M.D., E. Neuman, C.W. Gockel, and R.E. Highton. "Onchocerciasis in Kenya, 9, 11 and 18 Years After Elimination of the Vector." Bulletin of the World Health Organization 37 (1967):195-212.

Rolland, A. "Relation Entre l'Onchocercose et Zone d'Habitation: Resultats de l'Etude Geographique et Medicale d'un Terroir de la Volta Rouge (Benin, Niger, Haute Volta)." Doc. Mimeog. Geneva: WHO, 1975. (WHO/ONCHO/WP 75.21).

Scudder, T. The Development Potential of New Lands Settlement in the Tropics and Subtropics. Washington, D.C.: Agency for International Development, September 1984.

Traore, M.J.P. "Unit, de D,veloppement Economique, 6e Session du C.C.E." June 1985.

Vale, G.A. "New Field Methods for Studying the Responses of Tse-Tse Flies." Bull. Ent. Res. 64 (1974):199-208.

Vale, G.A. "Field Studies of the Responses of Tse-Tse Flies and Other Diptera to Carbon Dioxide, Acetone and Other Chemicals." Bull. Ent. Res. 70 (1980):563-70.

Vale, G.A. "Prospects for Using Stationary Baits To Control and Study Populations of Tse-Tse Flies." Zim. Sci. News 15 (1981):181-6.

White, P.T., M. Coleman, and B.P. Jupp. "Swamp Rice Development, Schistosomiasis, and Onchocerciasis in Southeast Sierra Leone." Ann. J. Trop. Med. and Hyg. 31 (1983):490-498.

World Bank. Toward Sustained Development in Sub-Saharan Africa. Washington, D.C.: World Bank, 1984.

World Bank. "Health Problems and Policies in the Developing Countries." World Bank Staff Working Paper No. 412. Washington, D.C., n.d.

World Health Organization. "Expert Committee on Onchocerciasis. Second Report." WHO Technical Report Series No. 335. 1966.

World Health Organization. "Independent Commission on the Long-Term Prospects of the Onchocerciasis Control Program, Final Report." August 1981.

World Health Organization/Onchocerciasis Control Program. "Senegambia Project: Onchocerciasis Control in Guinea, Guinea-Bissau, Mali, Senegal, and Sierra Leone." (Disease Prevention and Control in Water Development Schemes.) Geneva, 1981. (VBC 81.2).

World Health Organization/Onchocerciasis Control Program. "Impact of the Program on the Regions of Mogtedo-Rapadama, Bama-Samandeni, Banfora, Landa-Pozenda-Binah-Helota: Changes Taking Place Between 1975 and 1984." 1984. (OCP/GVA 84.1).

World Health Organization/Onchocerciasis Control Program. "L'Onchocercose dans la Region de Bandiagara, Epidemiologie et Lutte, Actions et Resultats d'OCP." October 1982.

World Health Organization/Onchocerciasis Control Program. "Onchocerciasis Control Programme in the Volta Basin Area: Evaluation Report, 1974-79." Part I and Part II (Economic Review Mission -- Independent Commission). 1978. (OCP 78.2).

World Health Organization/Onchocerciasis Control Program. "Plan of Operations for the Implementation of the Long-Term Strategy During the Third Financial Phase (1986-1991)." 1985. (OCP 17.5.85).

World Health Organization/Onchocerciasis Control Program. "Report on the Socioeconomic Development of the Zones Cleared of Onchocerciasis in Upper Volta." July 1983.

World Health Organization/Onchocerciasis Control Program. "Ten Years of Onchocerciasis Control in West Africa." Evaluation of the activities of the Onchocerciasis Control Program in the Volta Basin area (until June 1984). June 1984. (OCP

84.3).